



A Natural Resource Condition Assessment for Sequoia and Kings Canyon National Parks

Appendix 20b - Biodiversity, Supplemental Information

Natural Resource Report NPS/SEKI/ NRR—2013/665.20b



ON THE COVER

Giant Forest, Sequoia National Park
Photography by: Brent Paull

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Appendix 20b - Biodiversity, Supplemental Information

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Contents

	Page
Introduction.....	1
Biodiversity Reference Conditions	1
Spatial Analysis	1
Species Richness and Diversity by Elevation.....	7
Birds.....	7
Mammals	12
Plants.....	18
Mammals	26
Assessing the Elevation Distribution of Indicator Plant Species.....	43
Assessment.....	47

Figures

	Page
Figure S1. This figure shows which CWHR types would be selected using a 70% cutoff rule for the Wrentit.....	2
Figure S2. Species richness using a 70% cutoff rule for birds	3
Figure S3. Species richness using a 70% cutoff rule for mammals.....	4
Figure S4. Rarefaction plots of bird diversity by elevation.	9
Figure S5. Map of bird species richness by elevation using estimated species richness based on a sample size of 1000 birds.....	10
Figure S6. Estimated bird diversity in 500 m elevation zones based on rarefaction	11
Figure S7. Estimated mammal species richness in 500 m elevation zones based on rarefaction	14
Figure S8. Estimated herpetofauna diversity in 500 m elevation zones based on rarefaction	17
Figure S9. Estimated plant diversity in 500 m elevation zones based on rarefaction.....	18
Figure S10. The sampling intensity of birds by land cover type (as for mammals in figure 13).....	19
Figures S11. The rarefaction curves for the bird species of SEKI NP, as calculated using 500 observations as a cutoff below which values for that habitat type were not considered statistically robust.....	25
Figures S12. The rarefaction curves for the mammal species of SEKI NP, as calculated using 200 observations as a cutoff below which values for that habitat type were not considered statistically robust	31
Figure S13. The sampling intensity by habitat of different habitat types.	32
Figures S14. The rarefaction curves for the reptiles and amphibians species of SEKI NP, as calculated using 100 observations as a cutoff below which values for that habitat type were not considered statistically robust	38
Figures S15. The rarefaction curves for the plant species of SEKI , as calculated using 275 observations as a cutoff below which values for that habitat type were not considered statistically robust, and 2000 observations for elevation zone species richness	42
Figure S16. Three attempts to roll up biodiversity that were amalgamated into the final roll-up (Figure 27)	48
Figure S17. A map of SEKI identifying the 12 major watersheds named and number in Table S15.	51

Figures (continued)

	Page
Figure S18. Rarefaction graphs for estimating species richness for (a) birds, (b) mammals; and (c) herpetofauna; and (d) plants.....	52
Figure S18 (continued). Rarefaction graphs for estimating species richness for (d) plants. n = 1184.....	53

Tables

	Page
Table S5. Refer to Table 7 in text.	7
Table S6. Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m elevation category	12
Table S7. Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m elevation category	15
Table S9. Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category	20
Table S10. Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category	26
Table S11. Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category.....	33
Table S12. This table shows plant diversity by elevation zone, with a minimum of 2000 observations per zone.....	39
Table S13. Rarefaction table for species richness and diversity values for plant species by California Wildlife Habitat Relationship type in SEKI using an observation cutoff from 275 observations to 3000 observations.	40
Table 14. The conditional Sorensen's index of dissimilarity of plant species by CWH type.....	41
Table S15 Dominant / Indicator species of the Sequoia Kings Canyon vegetation map and the distribution attributes of the polygons in which they dominate.	43
Table S16. Output statistics for assessing biodiversity condition by watershed.....	49
Table S17. Watershed Identification lookup table. Watershed numbers correspond to watersheds in Figure S17 and are linked to rarefaction graphs for each taxa for each watershed (Figure S18).	51

Introduction

The supplemental information section contains more detailed information on analyses presented in the main body of the text. This includes tables, rarefaction curves and other figures. These parallel the structure are presented sequentially, for birds, mammals, reptiles & amphibians, and plants. In the interests of having a complete set of data in one place, some images and data from the report are repeated here.

Biodiversity Reference Conditions

SI Table 1-4. Species list of taxa that occur in the Wildlife Observation Database (WOD), the number of occurrences and. This species list was used to populated Table 4 (p.18), Figure 8 (p.20), Table 5, (p.22) and other data on species richness assessments

Spatial Analysis

Unequal Sampling and Data Treatment

For terrestrial vertebrates we faced a challenge. Owing to the movement of animals, and the potential for erroneous observations, we ought to consider the degree to which an observation of a species in a location actually represents the use of that particular habitat. This problem can take three forms. First, it can be a location error. Observations collected prior to GPS locations may be approximate, and therefore an observation of a species in one habitat type might actually be in some adjacent habitat type. Second, we might have an actual location of the person who observed the wildlife, but the wildlife may have been in a different habitat patch. This could either be a result of the observer failing to detect the habitat difference, or because the habitat patch is too small to appear on a SEKI map (e.g., slivers of riparian willow habitats). Third, the use of a particular habitat at a particular point in time when it was observed may be anomalous for that taxa. Every species has some suite of habitats that it frequents, and others that it may pass through in transit. Thus, species richness patterns for habitat designations are in need of interpretation. General aggregations of species may, however, contain a suite of observations that really don't belong to that habitat type.

Since animal observations don't necessarily reflect habitat use, we decided to try and map species richness by species served within each habitat type (Figure S1). There are many possible ways to do this. We developed one rule that works as follows (Figure S1): starting with the habitat type containing the most observations, we could accept as habitat all WHR types until we account for some percentage, let's say 70%, of the observations. Any habitat types not included in the 70% cutoff would be assumed to be vagrant sightings. Two problems occur with this sort of a rule-based method, as is illustrated in Figure 16. The first is that a habitat deemed 'outside' the modal habitat may be little differentiated from one that falls within the rule, as illustrated by the distinction between Sierran mixed conifer forest and mixed chaparral use by wrentits (Figure S1). Thus, any cutoff value is arbitrary. A second problem is that this sort of rule does not account for sampling intensity within a particular habitat. So, for example, wrentits could be the only species observed within a poorly sampled urban habitat type, but then be excluded because

these observations get swamped by those in better sampled environments (this is not the case for wrentits and urban habitats, by the way).

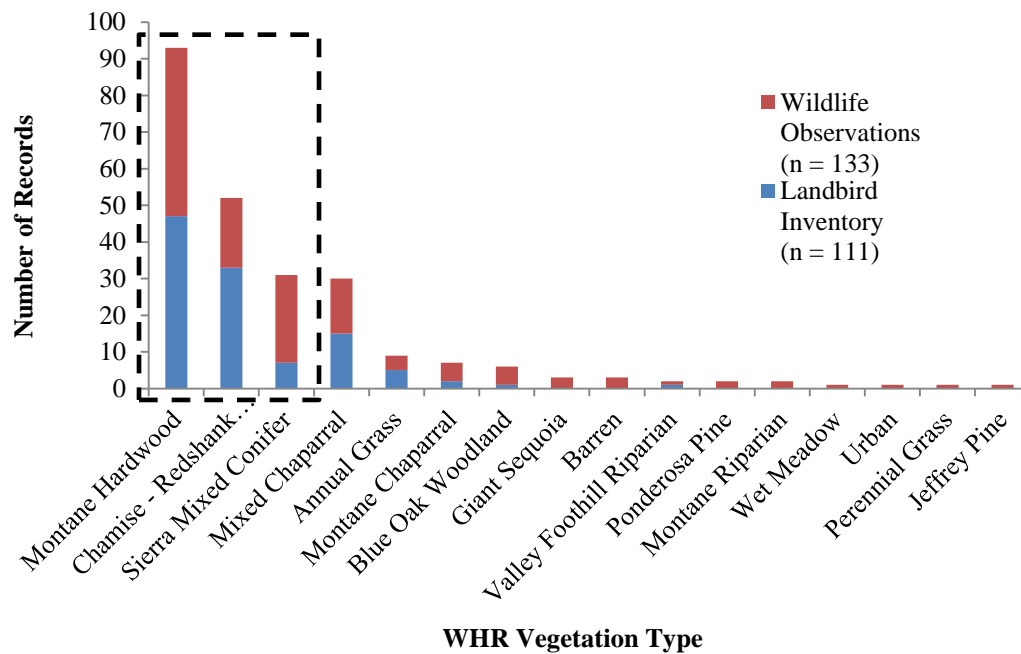


Figure S1. This figure shows which CWHR types would be selected using a 70% cutoff rule for the Wrentit.

In initial attempts to assess species richness, we used the 70% cutoff rule for birds (Figure S2) and mammals (Figure S3). These maps show general patterns of diversity with respect to elevation similar to those with no cutoff, where low elevation systems are more diverse than higher elevations, but species richness values change as we reduce the number of species that count in each elevation zone.

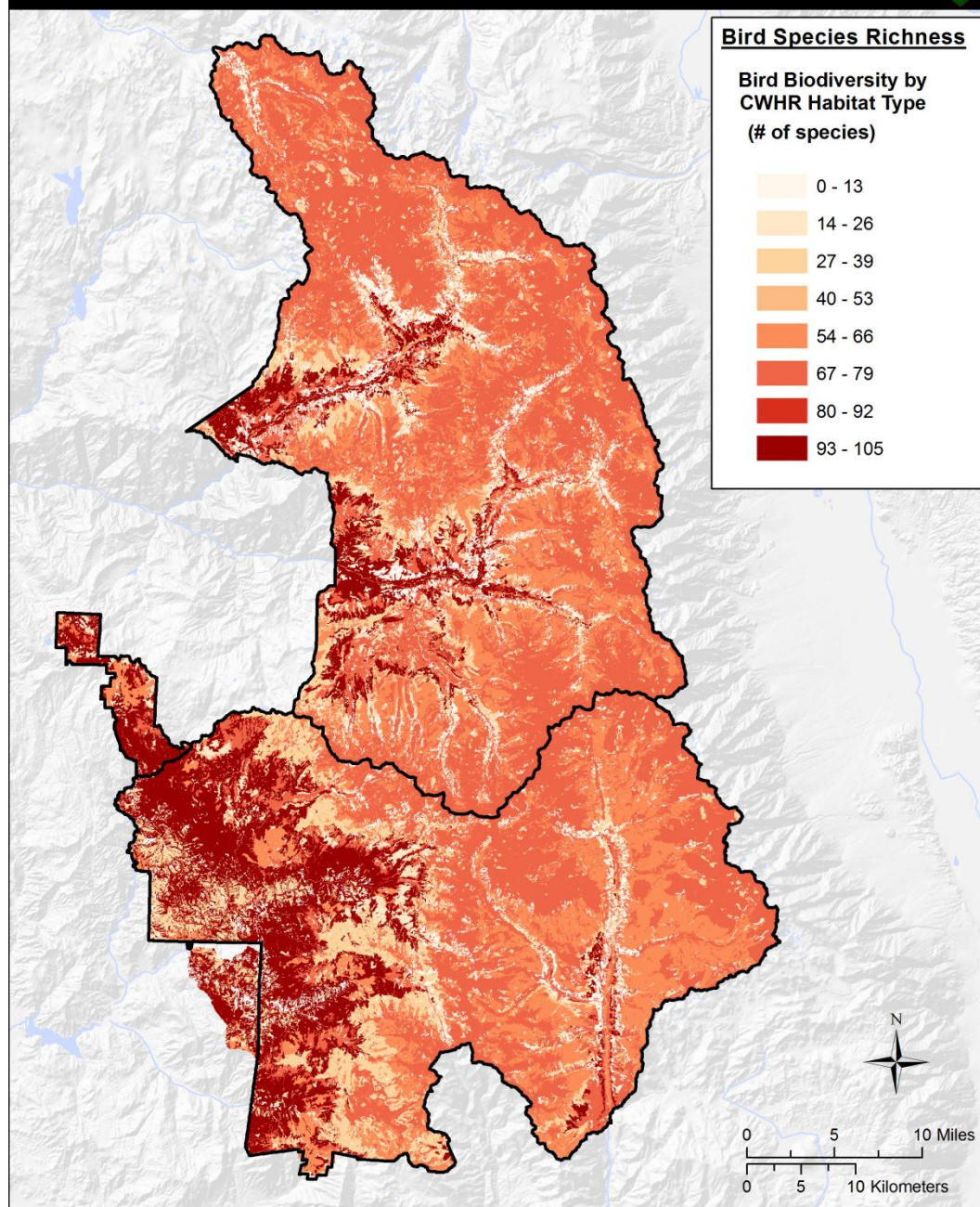


Figure S2. Species richness using a 70% cutoff rule for birds. The richness is out of a total of 217 taxa.

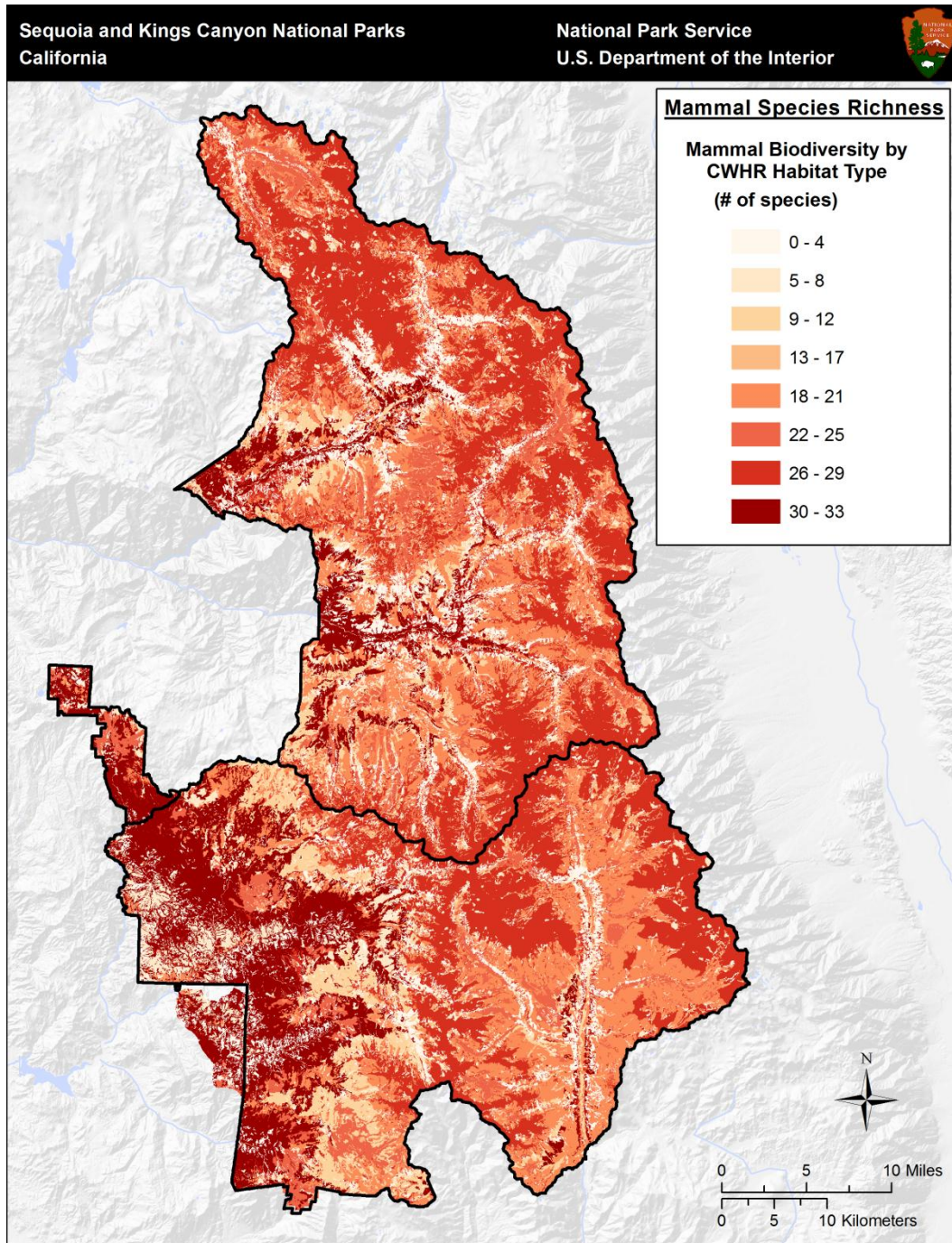


Figure S3. Species richness using a 70% cutoff rule for mammals . The richness is out of a total of 88 taxa.

We concluded that the arbitrary 70% rule does was not sufficient and we needed a different set of criteria when comparing richness using rarefaction. Thus, we did rarefaction using three methods. The first simply uses all observations. The second set of rarefaction uses a rule that species are counted only if they have three or more occurrences in a CWHR habitat type or 500 m elevation class unless there are five or fewer total observations or if all observations occur in

sets of three or fewer within any grouping. This method treats rare occurrences among common species as anomalous. A third set of rarefactions was conducted using a different rule set for eliminating unusual occurrences. In this we used a 95% cut-off, as in the 70% cut-off described above. Habitats or elevation classes were ranked from most to fewest occurrences; we counted occurrences until we hit 95% of all occurrences for that species, and then eliminated the remainder as spurious. Again, every species that was observed had at least one occurrence. This third method eliminated the largest number of occurrences and results in the larger number of occurrences and resulted in lower estimates of species richness. Cross correlation among these methods revealed high correlations. As a result, we plot the rarefaction estimates of species richness at a chosen sample size given all of the data observations.

Species Richness and Diversity by Elevation

Full rarefaction results for birds, mammals, herpetofauna and plants by elevation. These data represent the full rarefaction data set considered in the analysis of species richness by elevation category, a graphical depiction of estimated species richness by elevation and a map of richness by elevation category for each taxonomic group. A subset of these data appear as Tables 7-10 in the main body of the report.

Birds

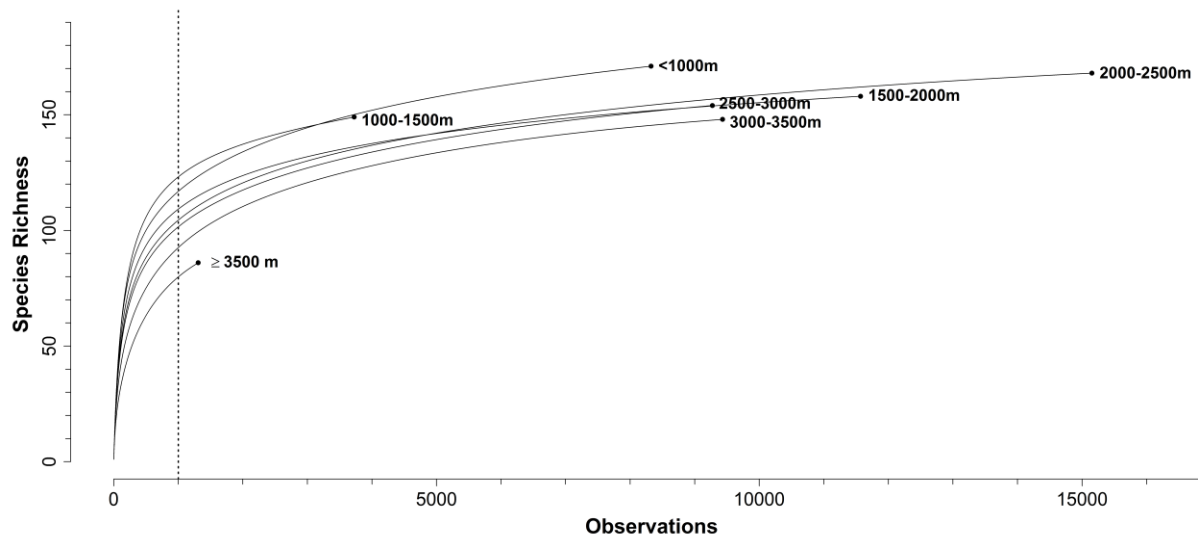
The complete bird rarefaction data, by elevation is presented here.

Table S5. Refer to Table 7 in text. Complete rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Bird observations include both the Wildlife Observation Databases as well as those collected by the International Bird Program. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of projecting estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 1000	n = 3000	n = 5000	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
A. All Observations								
0-999	116.9	144.4	157.8	171 (8,324)	196 (14.7)	191.7 (6.5)	4.39	60.3
1000-1499	123.1	144.8	NA	149 (3,725)	176.1 (21.0)	162.1 (6.1)	4.39	56.8
1500-1999	109.2	131.9	141.9	158 (11,569)	175.1 (12.2)	173.1 (6.2)	4.27	52.3
2000-2499	104.4	130.1	142.1	168 (15,152)	179.7 (7.4)	185.2 (6.5)	4.16	44.4
2500-2999	101.5	127.0	139.3	154 (9,274)	170.9 (10.3)	174 (6.4)	4.07	37.7
3000-3499	92.6	120.7	133.6	148 (9,432)	159.9 (7.8)	163.2 (6.3)	3.81	29.0
>=3500	79.9	NA	NA	86 (1,309)	102.5 (10.4)	104.7 (5.1)	3.31	16.0

Table S5 (continued). Refer to Table 7 in text. Complete rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Bird observations include both the Wildlife Observation Databases as well as those collected by the International Bird Program. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of projecting estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 1000	n = 3000	n = 5000	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
B. Three Observation Rule								
0-999	113.0	133.5	141.0	147 (8,290)	169 (33.4)	152.7 (5.5)	4.37	59.8
1000-1499	118.1	130.7	NA	132 (3,705)	135.7 (6.5)	133.9 (5.5)	4.36	56.2
1500-1999	106.9	125.2	131.3	138 (11,541)	148.5 (31.1)	140.9 (5.2)	4.25	52.0
2000-2499	101.9	122.7	130.4	142 (15,112)	151 (12.5)	146.1 (5.4)	4.14	44.2
2500-2999	97.7	116.0	122.3	128 (9,236)	140 (20.2)	132.2 (5.3)	4.05	37.4
3000-3499	89.6	112.1	120.2	127 (9,402)	131 (4.9)	130.7 (5.5)	3.79	28.8
>=3500	53.2	NA	NA	54 (1,264)	57 (NA)	54.9 (3.6)	3.15	14.9
C. 95% Rule								
0-999	91.2	104.8	111.1	116 (7,496)	125.4 (9.2)	124.8 (4.7)	4.18	51.2
1000-1499	58.0	NA	NA	64 (2,282)	69.2 (8.3)	69.2 (3.7)	3.62	29.2
1500-1999	94.3	108.8	114.7	122 (10,731)	126 (4.9)	126.8 (5.0)	4.16	48.5
2000-2499	90.4	105.4	111.9	124 (14,704)	126.3 (2.8)	129.1 (4.9)	4.06	41.9
2500-2999	78.3	92.5	98.6	104 (8,453)	108 (4.4)	109.5 (4.9)	3.85	32.1
3000-3499	65.0	78.9	85.4	92 (8,630)	98.1 (6.0)	101.3 (4.8)	3.55	24.6
>=3500	NA	NA	NA	25 (681)	25.7 (2.3)	26.7 (2.5)	2.36	7.7



6 **Figure S4.** Rarefaction plots of bird diversity by elevation. Each curve plots the projected number of species that would be sampled, on average for a specified number of bird observations. Each line represents a 500 m elevation band. The vertical line represents the number chosen from which to estimate species richness. The length of each line represents the total number of bird observations for that elevation zone.

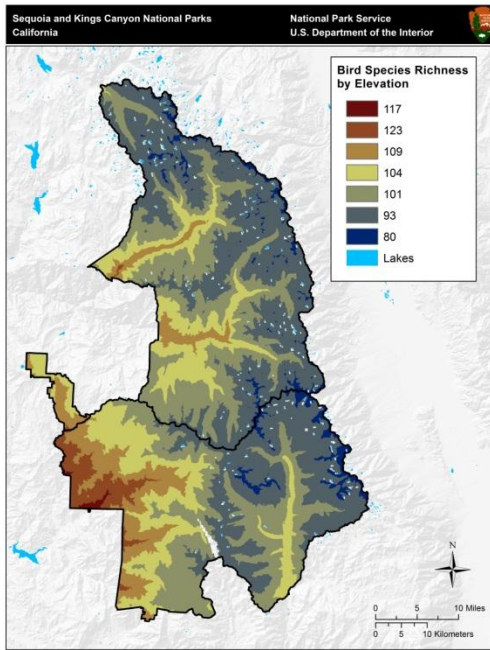


Figure S5. Map of bird species richness by elevation using estimated species richness based on a sample size of 1000 birds. Species richness is estimated using individual resampling, rarefaction (Gotelli and Colwell 2001). Note that the colors are in elevation sequence such that the second classification category (light brown) is 1000-1500m and represents the peak diversity by elevation with an estimated 123 species.

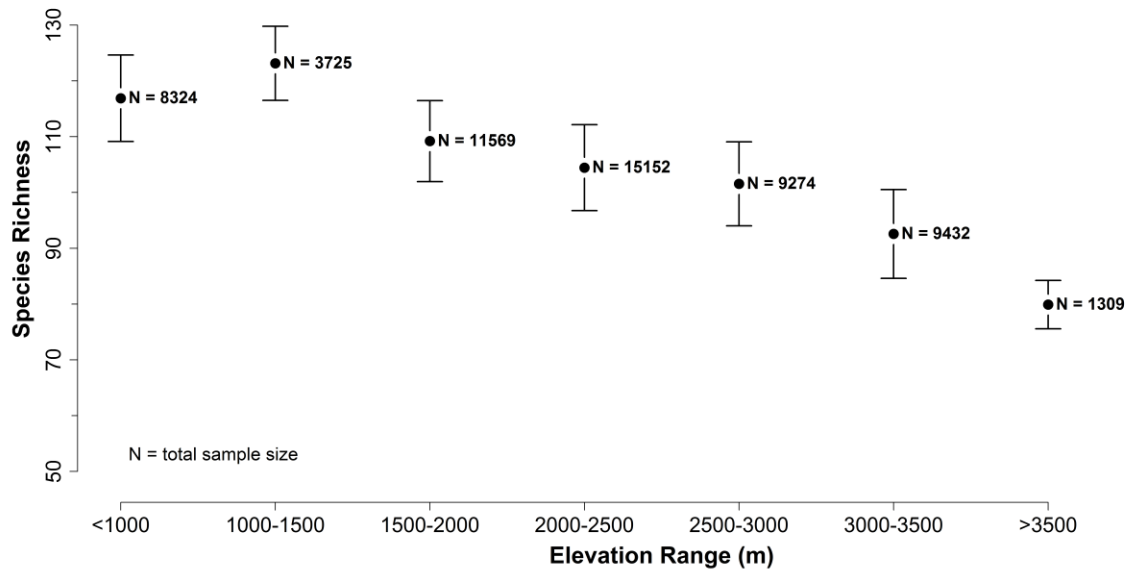


Figure S6. Estimated bird diversity in 500 m elevation zones based on rarefaction. Owing to the random resampling associated with rarefaction, a standard estimate of projected species richness is estimated and plotted alongside the species richness estimate. Numbers represent the size of the pool of observations from which to draw 1000 observations to estimate richness.

Mammals

The mammal data does not include a map of species richness estimates by elevation, but only the full rarefaction table and a plot of estimated richness by elevation, as summarized in table 9 in the main body of the report.

Table S6. Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Mammal observations are strongly influenced by observability bias based on body size. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 500	n = 1000	n = 1500	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
A. All Observations								
0-999	28.4	36.1	41.1	47 (2420)	55.2 (7.8)	58.1 (3.8)	2.38	7.4
1000-1499	38.2	45.7	NA	49 (1390)	52.6 (4.0)	55.4 (3.6)	2.73	9.9
1500-1999	42.3	52.3	57.9	62 (2095)	67.5 (5.3)	69.8 (4.1)	2.81	9.3
2000-2499	38.6	46.4	51.0	59 (3126)	68.2 (9.7)	67.8 (4.1)	2.76	9.1
2500-2999	33.7	41.2	45.7	48 (1839)	54.9 (6.8)	57.5 (3.7)	2.60	8.9
3000-3499	31.5	38.7	43.4	52 (2973)	63.1 (10.4)	65.8 (4.2)	2.70	10.7
>=3500	24.3	NA	NA	25 (561)	40 (NA)	28.8 (2.5)	2.29	6.5
B. Three Observation Rule								
0-999	24.4	28.4	30.0	31 (2399)	31 (0.7)	31.3 (2.8)	2.33	7.3
1000-1499	31.6	34.3	NA	35 (1369)	35.3 (1.9)	35.6 (2.9)	2.66	9.6
1500-1999	38.4	45.1	48.2	50 (2077)	52.5 (4.9)	52.3 (3.5)	2.76	9.1
2000-2499	36.7	42.7	45.7	50 (3113)	57.5 (23.6)	53.2 (3.5)	2.73	9.1
2500-2999	28.5	31.6	32.6	33 (1818)	33.5 (3.7)	33.6 (2.8)	2.54	8.7

Table S6 (continued). Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Mammal observations are strongly influenced by observability bias based on body size. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 500	n = 1000	n = 1500	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
3000-3499	28.5	32.9	35.1	38 (2954)	41 (11.7)	40.0 (3.0)	2.66	10.5
>=3500	19.0	NA	NA	19 (555)	19 (NA)	19 (2.2)	2.23	6.3
C. 95% Rule								
0-999	23.2	27.7	30.0	32 (2321)	33.5 (3.5)	34.1 (2.8)	2.25	6.9
1000-1499	26.9	NA	NA	31 (991)	32.4 (2.5)	35.1 (2.9)	2.34	6.8
1500-1999	35.6	43.2	47.1	49 (1897)	51.3 (3.1)	53.3 (3.5)	2.60	7.8
2000-2499	32.8	38.8	42.2	47 (3025)	50 (4.8)	50.7 (3.5)	2.64	8.6
2500-2999	23.9	28.6	31.0	31 (1503)	32.4 (2.5)	34.6 (2.9)	2.22	6.4
3000-3499	25.5	29.9	32.5	36 (2683)	39.7 (6.5)	41 (3.2)	2.51	9.1
>=3500	NA	NA	NA	10 (321)	13 (NA)	12.8 (1.6)	1.33	2.8

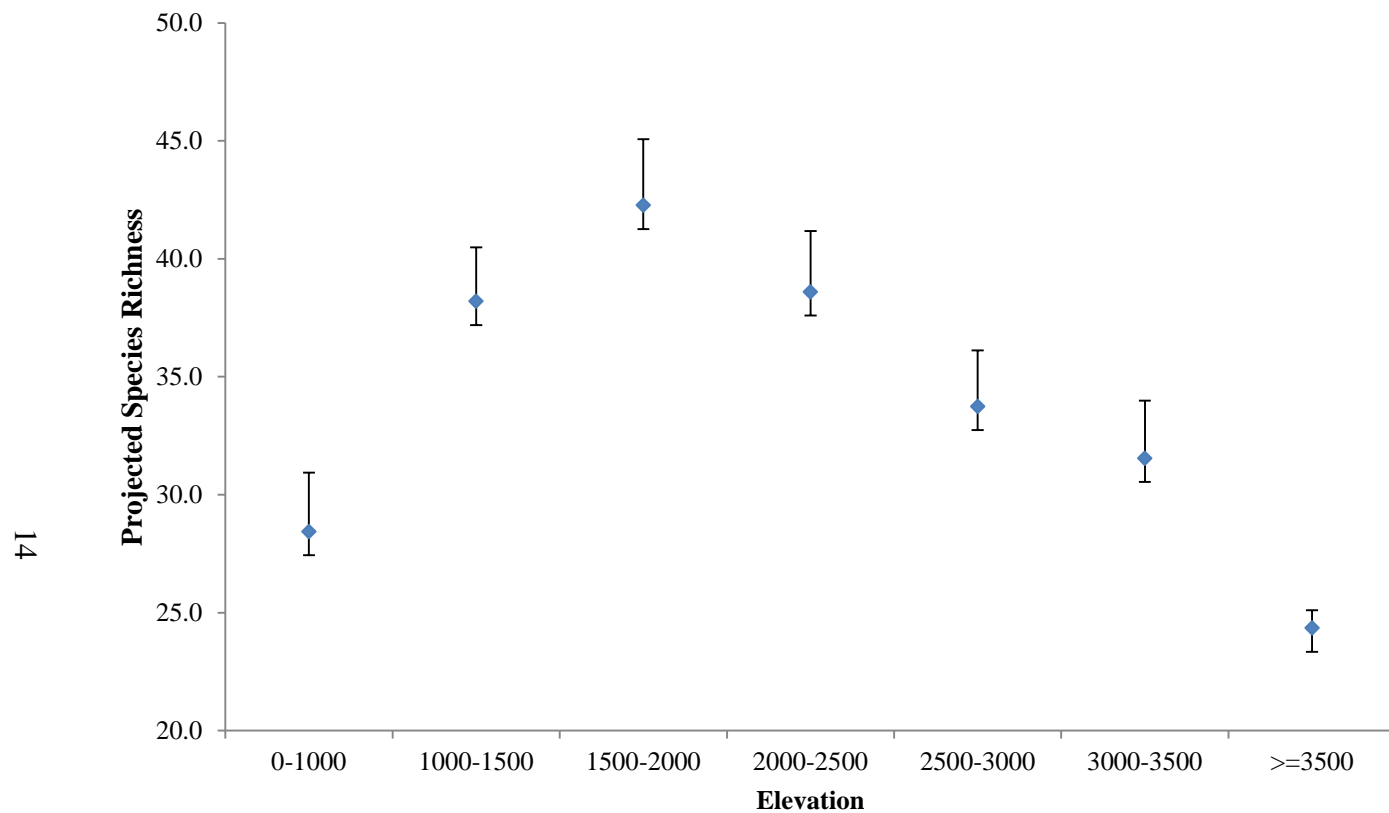


Figure S7. Estimated mammal species richness in 500 m elevation zones based on rarefaction. Owing to the random resampling associated with rarefaction, a standard estimate of projected species richness is estimated and plotted alongside the species richness estimate. Numbers represent the size of the pool of observations from which to draw 500 observations to estimate richness.

Herpetofauna

The herpetofauna data, like the mammals, does not include a map of mammal species richness estimates by elevation, but only the full rarefaction table and plot of estimated richness by elevation, as summarized in table 9 in the main body of the report.

Table S7. Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Herpetofauna are characterized by fewer observations than other taxonomic groups. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 250	n = 400	n = 500	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
A. All Observations								
0-999	24.4	26.5	27.5	30 (874)	35 (17.1)	34.1 (2.8)	2.77	12.7
1000-1499	21.8	23.4	23.9	24 (513)	24.2 (1.0)	25.4 (2.5)	2.63	10.0
1500-1999	24.1	26.1	27.2	28 (571)	35.5 (23.6)	38.1 (3.1)	2.64	8.3
2000-2499	21.7	23.0	23.4	24 (684)	25 (NA)	24.9 (2.4)	2.49	7.6
2500-2999	16.7	18.7	19.5	20 (581)	20.75 (2.3)	21.6 (2.2)	1.95	4.5
3000-3499	9.5	10.8	11.4	15 (2199)	15 (0.7)	15.4 (1.9)	1.25	2.7
>=3500	7.8	NA	NA	8 (270)	11 (NA)	11.1 (1.7)	0.80	1.6
B. Three Observation Rule								
0-999	23.4	24.9	25.5	27 (870)	30 (NA)	28.7 (2.5)	2.75	12.6
1000-1499	18.4	18.8	19.0	19 (504)	19 (NA)	19.3 (2.0)	2.56	9.7
1500-1999	22.1	23.1	23.6	24 (566)	27 (NA)	26.9 (2.4)	2.60	8.2
2000-2499	21.3	22.4	22.7	23 (683)	23 (NA)	23.3 (2.3)	2.48	7.6
2500-2999	13.5	13.9	14.0	14 (572)	14 (NA)	14 (1.9)	1.87	4.3
3000-3499	8.9	9.9	10.4	12 (2194)	12 (NA)	12 (1.6)	1.23	2.7
>=3500	5.0	NA	NA	5 (267)	5 (NA)	5 (1.1)	0.73	1.5

Table S7 (continued). Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m elevation category. Herpetofauna are characterized by fewer observations than other taxonomic groups. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao1 and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
Elevation Range	n = 250	n = 400	n = 500	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	1/Simpson*
C. 95% Rule								
0-999	20.7	22.0	22.6	24 (833)	27 (NA)	26.2 (2.4)	2.64	11.7
1000-1499	16.5	17.7	NA	18 (470)	18.3 (1.9)	20.3 (2.0)	2.41	8.6
1500-1999	17.8	19.2	20.0	20 (506)	26 (NA)	26.7 (2.6)	2.35	6.7
2000-2499	13.8	14.4	14.7	15 (582)	16 (NA)	19 (1.3)	2.14	5.8
2500-2999	8.7	9.0	NA	9 (466)	9 (0)	9 (1.5)	1.41	3.0
3000-3499	6.6	6.9	6.9	7 (2163)	7 (NA)	NA (NA)	1.15	2.6
>=3500	NA	NA	NA	2 (218)	2 (NA)	2 (0.7)	0.13	1.1

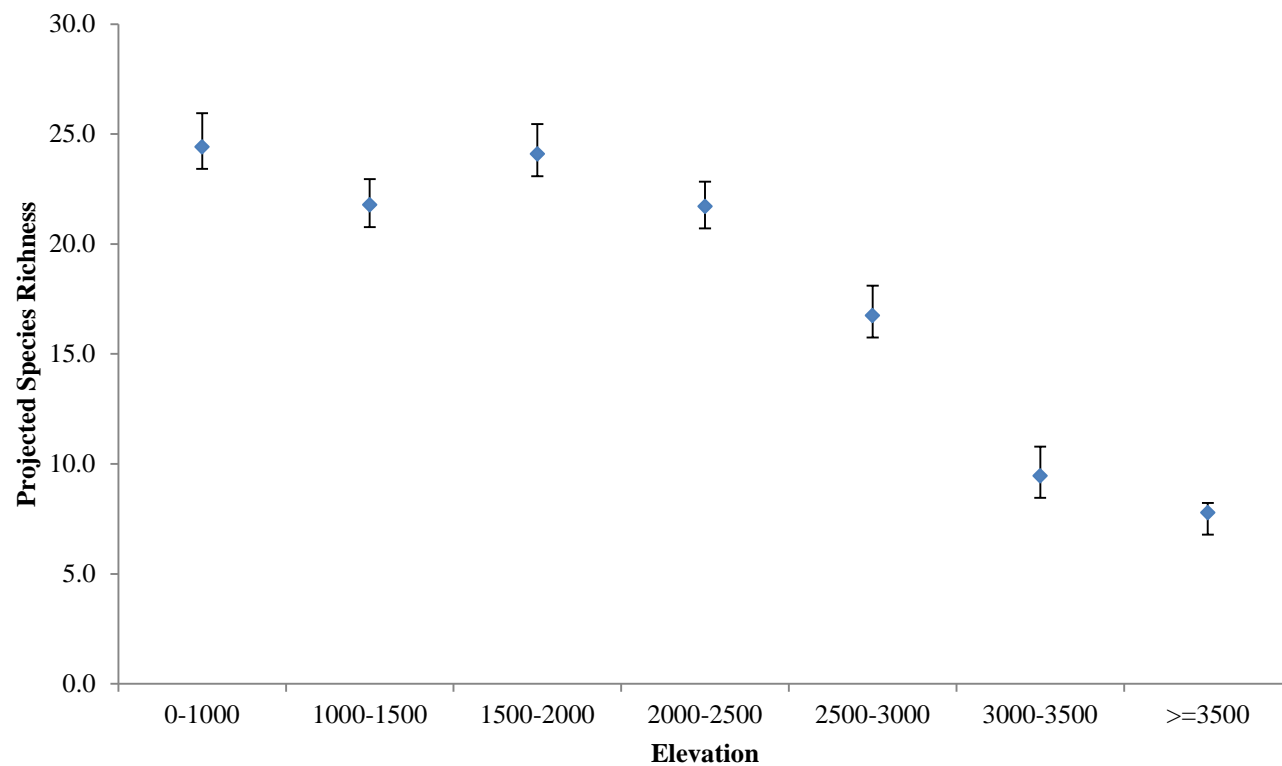


Figure S8. Estimated herpetofauna diversity in 500 m elevation zones based on rarefaction. Owing to the random resampling associated with rarefaction, a standard estimate of projected species richness is estimated and plotted alongside the species richness estimate. Numbers represent the size of the pool of observations from which to draw 250 observations to estimate richness.

Plants

Since plants are rooted in plots, we felt that we did not need to apply the same considerations for participation. Hence we do not have a broader rarefaction table than the one presented in the main body of the report. Here we only report on the figure of diversity by elevation, data that are presented in the table in the report, but presented graphically here.

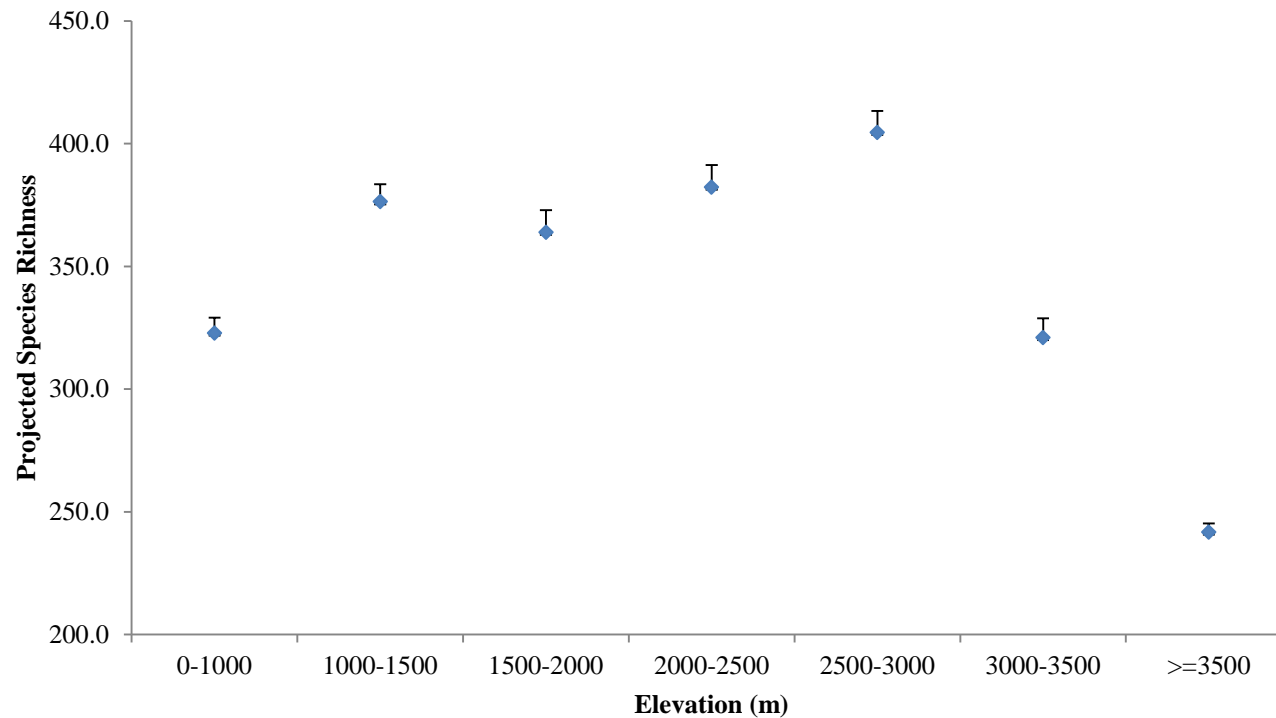


Figure S9. Estimated plant diversity in 500 m elevation zones based on rarefaction. Owing to the random resampling associated with rarefaction, a standard error estimate of projected species richness is estimated and plotted alongside the species richness estimate. Numbers represent species richness projected from 2000 random draws of the species data.

Species Richness and Diversity Assessment by Land Cover Type

Birds

Background information for the data shown on the report regarding bird diversity by land cover type. First, we examine sampling intensity (Figure S10). The rarefaction tables showing the three ways of using the observation data to develop species richness and diversity measures are presented here, followed by the rarefaction curves developed only for method A, the use of all observations.

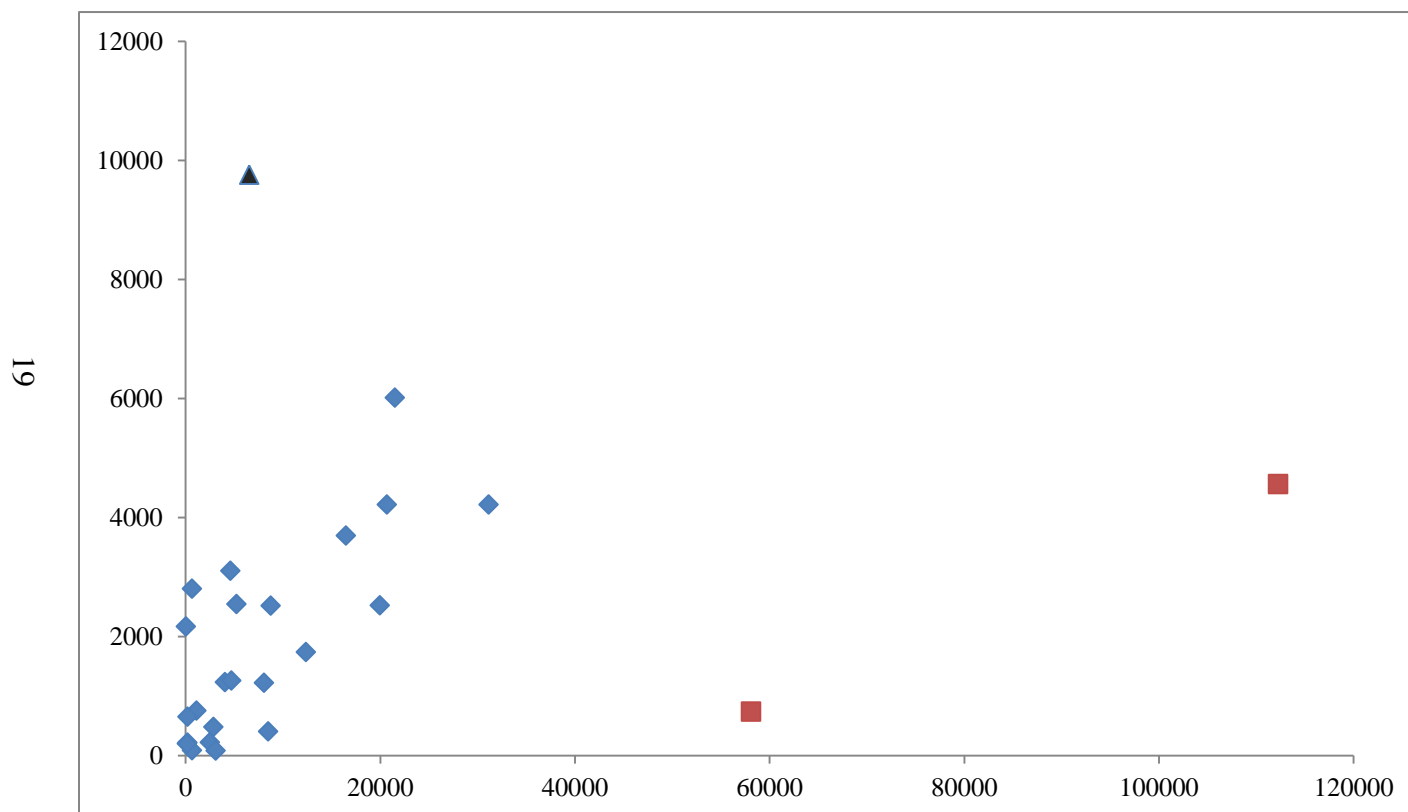


Figure S10. The sampling intensity of birds by land cover type (as for mammals in figure 13). Sagebrush is shown as a blue triangle and is the most over-sampled habitat type (observations per unit area of habitat). Barrens and sub-alpine conifer, the two largest habitat types have fewer observations per unit area than other types of habitat, as they do for mammals and herpetofauna. The remaining land cover types fit a line of increasing observations with increasing area within the park.

Table S9. Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 500	n = 1000	n = 2000					
A. All Observations								
Alpine Dwarf Shrub	NA	NA	NA	36 (89)	46.9 (8.4)	53.3 (4.3)	3.22	0.938
Annual Grass	NA	NA	NA	73 (220)	91.5 (10.2)	98.9 (4.6)	4.00	0.977
Aspen	NA	NA	NA	56 (221)	64 (6)	69.6 (3.7)	3.62	0.962
Barren	91.2	111.2	130.5	154 (4623)	205.7 (31.2)	179.7 (6.7)	4.07	0.973
Blue Oak Woodland	90.2	108.4	126.4	136 (2890)	159.2 (13.5)	158.3 (6.3)	4.15	0.978
Chamise - Redshank Chaparral	91.9	105.7	NA	110 (1244)	129 (13.3)	124.1 (5.6)	4.23	0.981
Jeffrey Pine	88.0	103.8	117.9	129 (3739)	139 (7.6)	139 (5.7)	4.11	0.976
Juniper	NA	NA	NA	75 (413)	91.5 (10.4)	93.1 (4.6)	3.80	0.967
Lodgepole Pine	80.3	95.4	111.6	130 (4280)	144.9 (9)	151.2 (6.2)	3.95	0.969
Mixed Chaparral	NA	NA	NA	104 (486)	117.6 (7.8)	121.8 (4.7)	4.26	0.981
Montane Chaparral	96.5	112.6	NA	124 (1756)	136.2 (8.3)	135.2 (5.7)	4.24	0.980
Montane Hardwood	112.5	129.3	143.3	167 (6104)	182.4 (9.6)	189.8 (6.5)	4.54	0.986
Montane Riparian	100.0	116.7	132.5	138 (2544)	157.5 (12.1)	156.1 (6.2)	4.35	0.983
Perennial Grass	97.9	NA	NA	108 (755)	138 (19)	124.8 (5.2)	4.28	0.982
Pinyon - Juniper	NA	NA	NA	43 (84)	70.3 (16.9)	87.5 (5.8)	3.50	0.960
Ponderosa Pine	76.3	NA	NA	80 (659)	85.5 (5)	87.8 (4.6)	4.03	0.979
Red Fir	85.4	101.9	117.8	123 (2536)	142.3 (12.4)	140.3 (5.9)	4.03	0.973
Subalpine Conifer	75.2	91.1	107.0	124 (4275)	140.5 (10.4)	141.7 (5.9)	3.76	0.961

Table S9 (continued). Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 500	n = 1000	n = 2000					
Giant Sequoia	78.5	93.1	107.5	121 (4070)	132.3 (8.3)	134.7 (5.8)	3.98	0.974
Sagebrush	82.6	NA	NA	92 (749)	119.6 (17.8)	112.9 (5.2)	3.98	0.974
Sierra Mixed Conifer	91.7	107.6	122.8	156 (8886)	183.6 (17.8)	177.5 (6.3)	4.21	0.979
Urban	81.5	96.0	110.0	113 (2322)	132 (13.3)	128.9 (5.7)	4.06	0.977
Valley Foothill Riparian	NA	NA	NA	62 (222)	95.3 (21.8)	87.1 (4.5)	3.71	0.965
Water	109.1	131.9	NA	139 (1279)	160 (11.4)	156.4 (5.7)	4.28	0.979
White Fir	83.5	102.2	NA	108 (1230)	135 (15.2)	134.4 (5.8)	3.98	0.974
Wet Meadow	95.0	110.6	124.4	129 (2575)	138.1 (6.6)	140.3 (5.9)	4.23	0.979
B. Three Observation Rule								
Alpine Dwarf Shrub	NA	NA	NA	11 (54)	11 (NA)	11.3 (1.1)	2.15	0.851
Annual Grass	NA	NA	NA	29 (158)	29 (NA)	29.2 (1.1)	3.28	0.959
Aspen	NA	NA	NA	27 (178)	27 (NA)	27.2 (1.7)	3.08	0.943
Barren	88.5	105.7	119.8	132 (4596)	154.8 (26.3)	138.7 (5.7)	4.04	0.973
Blue Oak Woodland	83.6	95.4	102.7	105 (2848)	110 (10.2)	107.1 (5)	4.09	0.977
Chamise - Redshank Chaparral	79.4	82.8	NA	83 (1209)	83 (1.3)	83.2 (4.5)	4.13	0.980
Jeffrey Pine	84.0	95.8	103.2	106 (3706)	107.5 (7.2)	106.7 (4.9)	4.07	0.976
Juniper	NA	NA	NA	40 (365)	40 (NA)	40 (2.9)	3.44	0.959
Lodgepole Pine	75.1	85.2	92.5	97 (4232)	102 (17.1)	98.8 (4.6)	3.90	0.968
Mixed Chaparral	NA	NA	NA	58 (419)	58 (NA)	58 (3)	3.87	0.975

Table S9 (continued). Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

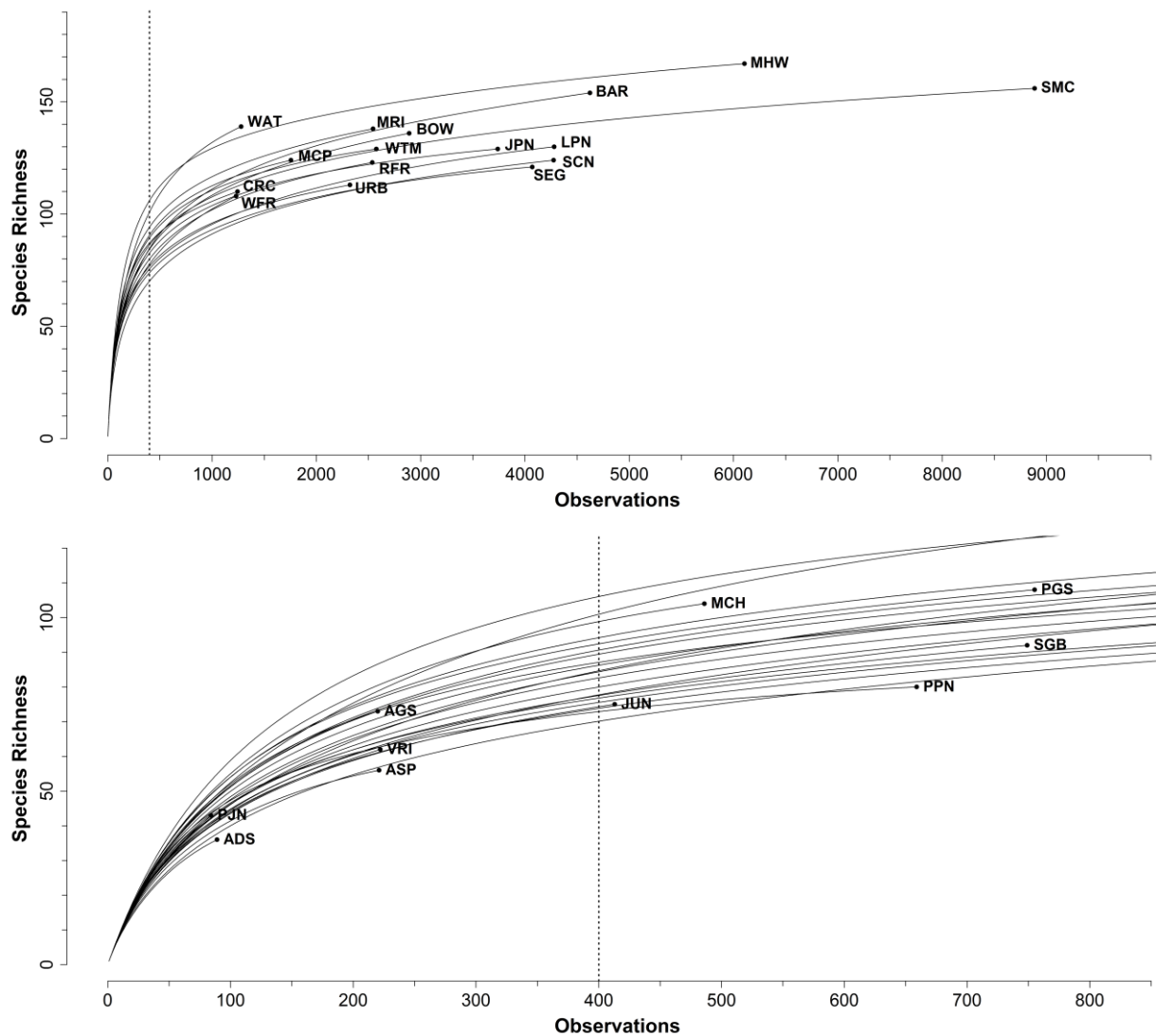
CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 500	n = 1000	n = 2000					
Montane Chaparral	86.2	93.6	NA	96 (1715)	102 (NA)	96.8 (4.9)	4.15	0.979
Montane Hardwood	110.1	124.6	134.2	145 (6073)	151 (7.1)	150.1 (5.2)	4.52	0.986
Montane Riparian	92.5	102.2	106.9	108 (2502)	118 (NA)	109.4 (5)	4.28	0.982
Perennial Grass	77.3	NA	NA	79 (718)	82 (11.7)	80 (4.1)	4.12	0.981
Pinyon - Juniper	NA	NA	NA	9 (40)	9 (NA)	9.3 (0.5)	2.08	0.864
Ponderosa Pine	56.9	NA	NA	57 (625)	57 (NA)	57 (3.8)	3.87	0.977
Red Fir	79.0	89.5	95.2	96 (2501)	96.8 (2.3)	96.9 (4.8)	3.97	0.972
Subalpine Conifer	71.4	83.6	92.6	98 (4240)	100 (3.7)	99.7 (4.8)	3.72	0.961
Giant Sequoia	74.4	85.0	92.5	96 (4034)	99 (NA)	97 (4.7)	3.94	0.974
Sagebrush	60.1	NA	NA	61 (709)	62 (NA)	61.5 (3.8)	3.79	0.971
Sierra Mixed Conifer	90.1	104.5	116.7	135 (8857)	162.5 (71.1)	140.7 (5.3)	4.19	0.979
Urban	74.6	82.7	86.6	87 (2287)	90 (NA)	87.8 (4.6)	4.00	0.976
Valley Foothill Riparian	NA	NA	NA	29 (181)	29 (NA)	29 (1.4)	3.18	0.949
Water	90.6	98.8	NA	100 (1223)	115 (NA)	101.5 (4.6)	4.13	0.977
White Fir	64.8	67.9	NA	68 (1178)	68 (0)	68 (4.1)	3.81	0.971
Wet Meadow	89.3	99.7	106.1	108 (2542)	117.3 (16.5)	111 (5.1)	4.18	0.979
C. 95% rule								
Alpine Dwarf Shrub	NA	NA	NA	3 (21)	3 (NA)	4.1 (0.9)	0.67	0.381
Annual Grass	NA	NA	NA	34 (132)	37.3 (3.6)	40.9 (2.5)	3.23	0.953

Table S9 (continued). Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 500	n = 1000	n = 2000					
Aspen	NA	NA	NA	5 (23)	6 (NA)	6.7 (1.2)	1.30	0.684
Barren	87.5	104.9	120.5	138 (4576)	207 (68.6)	155 (6.1)	4.03	0.973
Blue Oak Woodland	77.1	87.4	96.4	100 (2778)	104.5 (4.6)	106.8 (4.9)	4.02	0.976
Chamise - Redshank Chaparral	74.3	81.5	NA	83 (1147)	96.8 (17.4)	89.2 (4.7)	4.04	0.978
Jeffrey Pine	86.3	100.5	111.9	120 (3725)	129.4 (9.2)	126.2 (5.4)	4.09	0.976
Juniper	NA	NA	NA	15 (137)	18 (11.7)	20.9 (2.5)	2.29	0.879
Lodgepole Pine	76.8	88.9	100.4	112 (4246)	119.6 (6.2)	122.6 (5.4)	3.92	0.968
Mixed Chaparral	NA	NA	NA	38 (259)	40.5 (3.9)	40.9 (2.7)	3.31	0.955
Montane Chaparral	83.7	94.3	NA	101 (1670)	110.8 (8.8)	107.7 (5.1)	4.11	0.978
Montane Hardwood	110.9	126.4	138.3	157 (6081)	168.3 (8.3)	173 (6)	4.53	0.986
Montane Riparian	95.7	109.5	120.8	124 (2493)	132.3 (6.8)	132.3 (5.6)	4.30	0.982
Perennial Grass	NA	NA	NA	48 (345)	55 (10.3)	51.8 (3.2)	3.57	0.966
Pinyon - Juniper	NA	NA	NA	4 (14)	5 (NA)	6.4 (1.2)	1.05	0.582
Ponderosa Pine	NA	NA	NA	39 (444)	39.3 (1.3)	39.7 (3.1)	3.48	0.966
Red Fir	78.0	89.4	98.7	101 (2487)	105.5 (4.6)	106.8 (5.1)	3.96	0.972
Subalpine Conifer	70.6	82.8	93.2	103 (4228)	109.6 (6)	110.6 (5.1)	3.71	0.961
Giant Sequoia	72.2	82.7	92.0	100 (3994)	109.2 (9.7)	107.5 (5.1)	3.92	0.973
Sagebrush	NA	NA	NA	40 (478)	58 (49.1)	47.9 (3.5)	3.25	0.949
Sierra Mixed Conifer	90.6	105.6	119.2	145 (8864)	164.4 (16)	157.2 (5.8)	4.20	0.979

Table S9 (continued). Rarefaction results of bird observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 500	n = 1000	n = 2000					
Urban	72.9	81.7	88.8	90 (2266)	101.3 (14.8)	95.6 (4.8)	3.98	0.976
Valley Foothill Riparian	NA	NA	NA	20 (126)	20 (0.7)	20.2 (1.4)	2.73	0.916
Water	75.8	87.8	NA	88 (1012)	100 (9.3)	98.2 (4.7)	3.86	0.970
White Fir	56.8	63.9	NA	65 (1095)	87 (33.4)	74.2 (4.2)	3.67	0.967
Wet Meadow	91.5	104.4	114.7	118 (2554)	125.1 (6.1)	125.3 (5.5)	4.20	0.979



Figures S11. The rarefaction curves for the bird species of SEKI NP, as calculated using 500 observations as a cutoff below which values for that habitat type were not considered statistically robust. Note the different horizontal scale bars with the lefthand side of upper graph expanded and presented in the lower graph.

Mammals

The rarefaction tables showing the three ways of using the observation data to develop species richness and diversity measures are presented here, followed by the rarefaction curves developed only for method A, the use of all observations.

Table S10. Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 250	n = 500	n = 750					
A. All Observations								
Alpine Dwarf Shrub	NA	NA	NA	12 (29)	17 (17.1)	15.4 (1.7)	2.32	0.889
Annual Grass	NA	NA	NA	8 (16)	9 (3.4)	9.8 (1.5)	1.98	0.852
Aspen	NA	NA	NA	10 (32)	16 (NA)	13.7 (1.7)	2.04	0.842
Barren	28.2	35.4	40.0	50 (1563)	74 (23.3)	68.2 (4.1)	2.70	0.899
Blue Oak Woodland	20.2	25.0	28.2	29 (826)	34.6 (7.5)	36.8 (2.9)	2.29	0.857
Chamise - Redshank Chaparral	19.9	NA	NA	24 (418)	69 (NA)	47.6 (3.8)	2.24	0.849
Jeffrey Pine	28.9	36.6	NA	42 (708)	118.5 (179.5)	72 (4.1)	2.76	0.906
Juniper	NA	NA	NA	17 (70)	22.3 (8.3)	24.3 (2.4)	2.30	0.855
Lodgepole Pine	29.6	36.5	40.8	47 (1303)	53.1 (6)	57.2 (3.8)	2.77	0.905
Mixed Chaparral	NA	NA	NA	21 (102)	25.7 (5.9)	30 (2.7)	2.44	0.872
Montane Chaparral	28.7	NA	NA	31 (324)	38.2 (9)	38.3 (3)	2.48	0.855
Montane Hardwood	28.3	36.4	41.6	55 (2120)	66.1 (10.4)	65.8 (4)	2.63	0.891
Montane Riparian	38.3	47.5	NA	48 (522)	54.6 (6)	58.5 (3.8)	2.89	0.900

Table S10 (continued). Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 250	n = 500	n = 750					
Perennial Grass	NA	NA	NA	23 (96)	26 (4)	30.2 (2.7)	2.74	0.916
Pinyon - Juniper	NA	NA	NA	8 (25)	11.3 (7.6)	16.8 (1.3)	1.33	0.570
Ponderosa Pine	NA	NA	NA	18 (54)	22.2 (6.1)	26.4 (2.7)	2.57	0.901
Red Fir	28.8	35.4	NA	36 (540)	39.5 (4.2)	41.6 (3.1)	2.59	0.881
Subalpine Conifer	23.8	30.3	34.9	38 (961)	51 (12.7)	53.5 (3.4)	2.64	0.905
Giant Sequoia	33.0	41.5	46.4	49 (941)	55.9 (6.8)	58 (3.7)	2.66	0.859
Sagebrush	NA	NA	NA	20 (101)	29.3 (16.5)	30.3 (2.9)	2.46	0.883
Sierra Mixed Conifer	33.6	41.6	46.5	56 (1701)	62.9 (6.8)	64.8 (4)	2.84	0.895
Urban	NA	NA	NA	22 (210)	27 (17.1)	25.5 (2.4)	2.44	0.874
Valley Foothill Riparian	NA	NA	NA	13 (76)	18 (10.2)	22.4 (2.6)	1.69	0.687
Water	32.5	42.0	NA	45 (613)	56.7 (9.6)	66.1 (4.6)	2.86	0.916
White Fir	27.9	NA	NA	28 (254)	35 (13.2)	32.1 (2.5)	2.57	0.874
Wet Meadow	27.2	33.6	NA	36 (626)	47 (12.5)	48.8 (3.5)	2.61	0.887
B. Three Observation Rule								
Alpine Dwarf Shrub	NA	NA	NA	6 (22)	6 (NA)	6 (0)	1.77	0.826
Annual Grass	NA	NA	NA	3 (9)	3 (NA)	3 (0)	1.10	0.667
Aspen	NA	NA	NA	6 (28)	6 (NA)	6 (0)	1.70	0.798

Table S10 (continued). Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

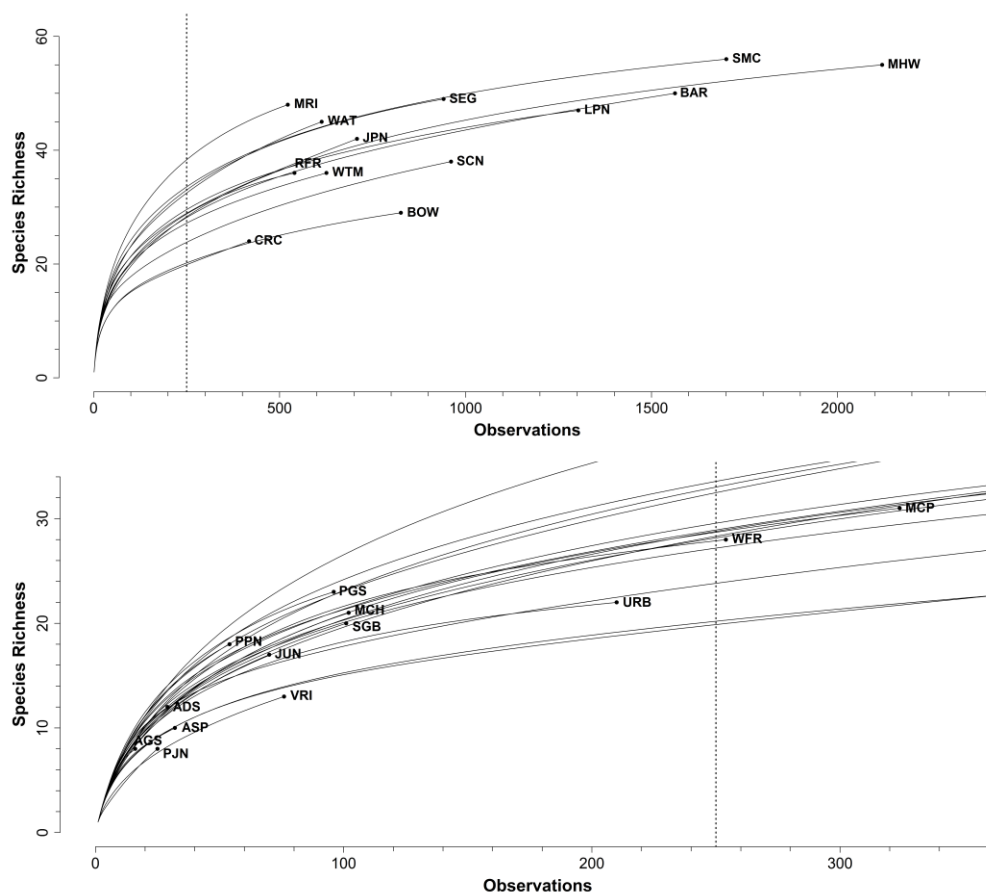
CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 250	n = 500	n = 750					
Barren	25.6	30.3	32.6	36 (1546)	41 (17.1)	38.3 (3)	2.64	0.897
Blue Oak Woodland	16.3	17.7	18.0	18 (812)	18 (0)	18 (2)	2.20	0.852
Chamise - Redshank Chaparral	15.1	NA	NA	16 (410)	17 (NA)	17.3 (2.1)	2.15	0.843
Jeffrey Pine	22.8	24.4	NA	25 (690)	26 (NA)	25.5 (2.4)	2.64	0.901
Juniper	NA	NA	NA	7 (57)	7 (NA)	7 (1.2)	1.72	0.787
Lodgepole Pine	25.9	29.4	30.7	32 (1282)	32.3 (1.9)	32.6 (2.8)	2.69	0.902
Mixed Chaparral	NA	NA	NA	8 (84)	8 (NA)	8 (1.4)	1.86	0.816
Montane Chaparral	19.6	NA	NA	20 (309)	21 (NA)	20.6 (2.2)	2.29	0.840
Montane Hardwood	27.0	33.8	37.8	46 (2108)	51.3 (8.3)	49.9 (3.4)	2.59	0.890
Montane Riparian	28.4	NA	NA	31 (497)	32.5 (7.2)	32.2 (2.7)	2.70	0.889
Perennial Grass	NA	NA	NA	10 (77)	10 (NA)	10 (1.3)	2.18	0.875
Pinyon - Juniper	NA	NA	NA	1 (16)	1 (NA)	NA (NA)	0.00	0.000
Ponderosa Pine	NA	NA	NA	7 (39)	7 (NA)	7 (0)	1.84	0.824
Red Fir	20.7	22.0	NA	22 (519)	22 (NA)	22.3 (2.3)	2.41	0.872
Subalpine Conifer	19.5	22.0	23.3	24 (943)	25.5 (7.2)	25.4 (2.2)	2.54	0.902
Giant Sequoia	29.3	34.5	36.9	38 (925)	41.3 (7.6)	40.6 (3.1)	2.57	0.854
Sagebrush	NA	NA	NA	12 (91)	13 (NA)	13 (1.6)	2.15	0.858
Sierra Mixed Conifer	32.2	39.0	42.8	49 (1691)	53.2 (6.1)	53.2 (3.6)	2.81	0.894

Table S10 (continued). Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 250	n = 500	n = 750					
Urban	NA	NA	NA	17 (204)	17 (NA)	17.3 (2)	2.33	0.867
Valley Foothill Riparian	NA	NA	NA	6 (68)	6 (0)	6 (0.9)	1.28	0.611
Water	23.0	25.4	NA	26 (586)	32 (NA)	28.7 (2.6)	2.67	0.909
White Fir	NA	NA	NA	21 (245)	22 (NA)	21.5 (2.1)	2.44	0.864
Wet Meadow	21.8	23.6	NA	24 (611)	24.5 (3.7)	24.8 (2.4)	2.50	0.882
C. 95% rule								
Alpine Dwarf Shrub	NA	NA	NA	4 (9)	5 (NA)	5.9 (1.1)	1.21	0.667
Annual Grass	NA	NA	NA	1 (1)	1 (NA)	NA (NA)	0.00	0.000
Aspen	NA	NA	NA	1 (1)	1 (NA)	NA (NA)	0.00	0.000
Barren	26.9	33.2	37.3	46 (1552)	64.2 (18.6)	62 (3.9)	2.67	0.898
Blue Oak Woodland	18.9	22.9	25.5	26 (820)	29 (4.8)	31.4 (2.7)	2.26	0.855
Chamise - Redshank Chaparral	15.7	NA	NA	18 (400)	33 (NA)	32.2 (2.9)	2.10	0.836
Jeffrey Pine	26.8	32.9	NA	37 (700)	82.5 (111.6)	57.3 (3.7)	2.72	0.904
Juniper	NA	NA	NA	4 (5)	5.5 (7.2)	10 (0.9)	1.33	0.720
Lodgepole Pine	27.8	33.7	37.2	42 (1290)	45.1 (3.7)	48.9 (3.5)	2.73	0.903
Mixed Chaparral	NA	NA	NA	12 (46)	12.6 (1.8)	14.1 (1.5)	2.13	0.842
Montane Chaparral	21.4	NA	NA	22 (276)	25 (4.8)	27.5 (2.6)	2.10	0.806
Montane Hardwood	26.3	33.2	37.4	48 (2093)	55.5 (8.4)	55.8 (3.6)	2.57	0.888

Table S10 (continued). Rarefaction results of mammal observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 250	n = 500	n = 750					
Montane Riparian	36.7	45.6	NA	46 (515)	52.6 (6)	57.4 (3.8)	2.85	0.897
Perennial Grass	NA	NA	NA	6 (32)	6.3 (1.9)	9.5 (1.8)	1.27	0.643
Pinyon - Juniper	NA	NA	NA	1 (1)	1 (NA)	NA (NA)	0.00	0.000
Ponderosa Pine	NA	NA	NA	3 (9)	3 (1.3)	3.9 (0.8)	0.85	0.494
Red Fir	25.3	29.7	NA	30 (530)	31.7 (3)	32.9 (2.7)	2.51	0.877
Subalpine Conifer	21.0	25.3	28.2	30 (948)	37 (10.3)	38.5 (2.8)	2.57	0.903
Giant Sequoia	31.2	38.8	43.0	45 (928)	50.1 (5.9)	51.5 (3.5)	2.61	0.855
Sagebrush	NA	NA	NA	8 (41)	11 (11.7)	14.2 (1.5)	1.44	0.685
Sierra Mixed Conifer	32.7	40.5	45.2	54 (1690)	59.6 (5.9)	61.6 (3.9)	2.82	0.894
Urban	NA	NA	NA	15 (176)	18 (11.7)	19.5 (2.2)	2.05	0.829
Valley Foothill Riparian	NA	NA	NA	5 (26)	5 (1.3)	5.5 (0.7)	1.38	0.719
Water	29.1	36.9	NA	38 (548)	46.3 (7.8)	55.7 (4.2)	2.73	0.905
White Fir	NA	NA	NA	22 (226)	27 (10.2)	26.6 (2.4)	2.29	0.843
Wet Meadow	25.4	30.3	NA	32 (621)	39 (10.3)	39.5 (3.1)	2.57	0.885



Figures S12. The rarefaction curves for the mammal species of SEKI NP, as calculated using 200 observations as a cutoff below which values for that habitat type were not considered statistically robust. Upper graph depicts entire range of values, with the lower graph expanding the left hand side of the upper graph to show curves at small sample sizes.

Reptiles and Amphibians

Sampling intensity of herpetofauna are depicted. The rarefaction tables showing the three ways of using the observation data to develop species richness and diversity measures are presented here, followed by the rarefaction curves developed only for method A, the use of all observations.

32

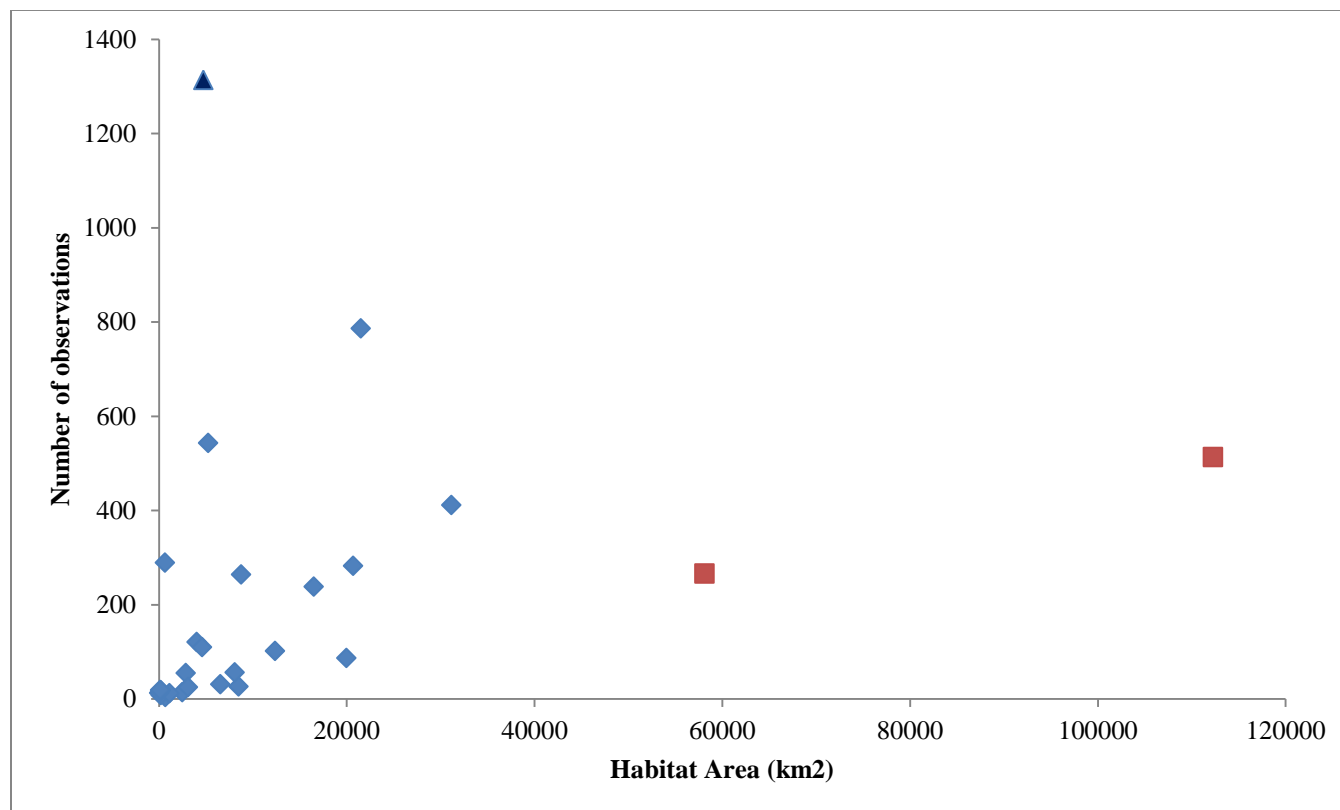


Figure S13. The sampling intensity by habitat of different habitat types. Two generally under-sampled types, barrens and sub-alpine conifers are shown as red squares. Dark blue triangle represents the over-sampled aquatic habitats. The remainder generally fit a line of increasing area and increasing numbers of observations. This sampling intensity is closely reflected in mammals (Figure 13).

Table S11. Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
CWHR name	n = 100	n = 200	n = 400	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
A. All Observations								
Alpine Dwarf Shrub	NA	NA	NA	3 (4)	3.5 (3.7)	6 (0.9)	1.04	0.625
Annual Grass	NA	NA	NA	7 (8)	14.5 (23.6)	28 (1)	1.91	0.844
Aspen	NA	NA	NA	8 (14)	8.6 (1.8)	10.2 (1.6)	2.01	0.857
Barren	13.8	16.4	19.0	20 (513)	22 (5.3)	23 (2.3)	2.03	0.802
Blue Oak Woodland	18.9	22.4	NA	24 (289)	26 (5.3)	27 (2.6)	2.63	0.907
Chamise - Redshank Chaparral	18.9	NA	NA	20 (121)	25 (10.2)	25.4 (2.5)	2.57	0.901
Jeffrey Pine	17.0	19.5	NA	20 (238)	21 (3.4)	21.4 (2.1)	2.25	0.813
Juniper	NA	NA	NA	8 (26)	8.5 (3.7)	9.5 (1.2)	1.85	0.808
Lodgepole Pine	13.6	16.8	NA	18 (282)	18.8 (2.3)	19.6 (2.1)	1.91	0.763
Mixed Chaparral	NA	NA	NA	18 (55)	21 (4)	24.5 (2.7)	2.45	0.876
Montane Chaparral	18.9	NA	NA	19 (102)	22.3 (7.6)	22.4 (1.9)	2.41	0.857
Montane Hardwood	20.4	23.9	26.7	29 (786)	35 (NA)	31 (2.7)	2.79	0.918
Montane Riparian	19.4	22.8	NA	24 (264)	25.5 (3.5)	26.9 (2.6)	2.60	0.897
Perennial Grass	NA	NA	NA	10 (12)	46 (NA)	69.5 (1.6)	2.21	0.875
Pinyon - Juniper	NA	NA	NA	6 (25)	6.3 (1.9)	7.4 (1.3)	1.20	0.560

Table S11 (continued). Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
CWHR name	n = 100	n = 200	n = 400	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
Ponderosa Pine	NA	NA	NA	9 (18)	11.5 (4.9)	19.1 (2.6)	1.90	0.796
Red Fir	NA	NA	NA	16 (87)	19.3 (7.6)	20.9 (2.3)	2.28	0.862
Subalpine Conifer	8.2	11.2	NA	13 (266)	23.5 (31.1)	49.7 (4.1)	1.38	0.666
Giant Sequoia	18.4	NA	NA	19 (110)	22.8 (6.5)	24.3 (2.3)	2.45	0.881
Sagebrush	NA	NA	NA	7 (31)	7 (1.3)	7.4 (1.1)	1.69	0.772
Sierra Mixed Conifer	20.2	22.8	24.9	25 (411)	26 (3.4)	26.6 (2.5)	2.72	0.908
Urban	NA	NA	NA	8 (13)	8.5 (1.5)	10.4 (1.6)	2.03	0.864
Valley Foothill Riparian	NA	NA	NA	11 (19)	20.3 (16.5)	40.5 (3.7)	2.08	0.820
Water	8.2	11.2	14.9	23 (1314)	27.2 (6.1)	30.9 (2.8)	1.31	0.637
White Fir	NA	NA	NA	15 (56)	22.5 (23.6)	20.3 (2)	2.41	0.893
Wet Meadow	9.7	12.9	16.6	18 (542)	19 (2.2)	21.6 (2.3)	1.44	0.654
B. Three Observation Rule								
Alpine Dwarf Shrub	NA	NA	NA	0 (0)	0 (NA)	NA (NA)	0.00	1.000
Annual Grass	NA	NA	NA	0 (0)	0 (NA)	NA (NA)	0.00	1.000
Aspen	NA	NA	NA	1 (3)	1 (NA)	1 (0)	0.00	0.000
Barren	12.4	13.6	14.0	14 (505)	14 (NA)	14 (1.9)	1.96	0.796

Table S11 (continued). Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

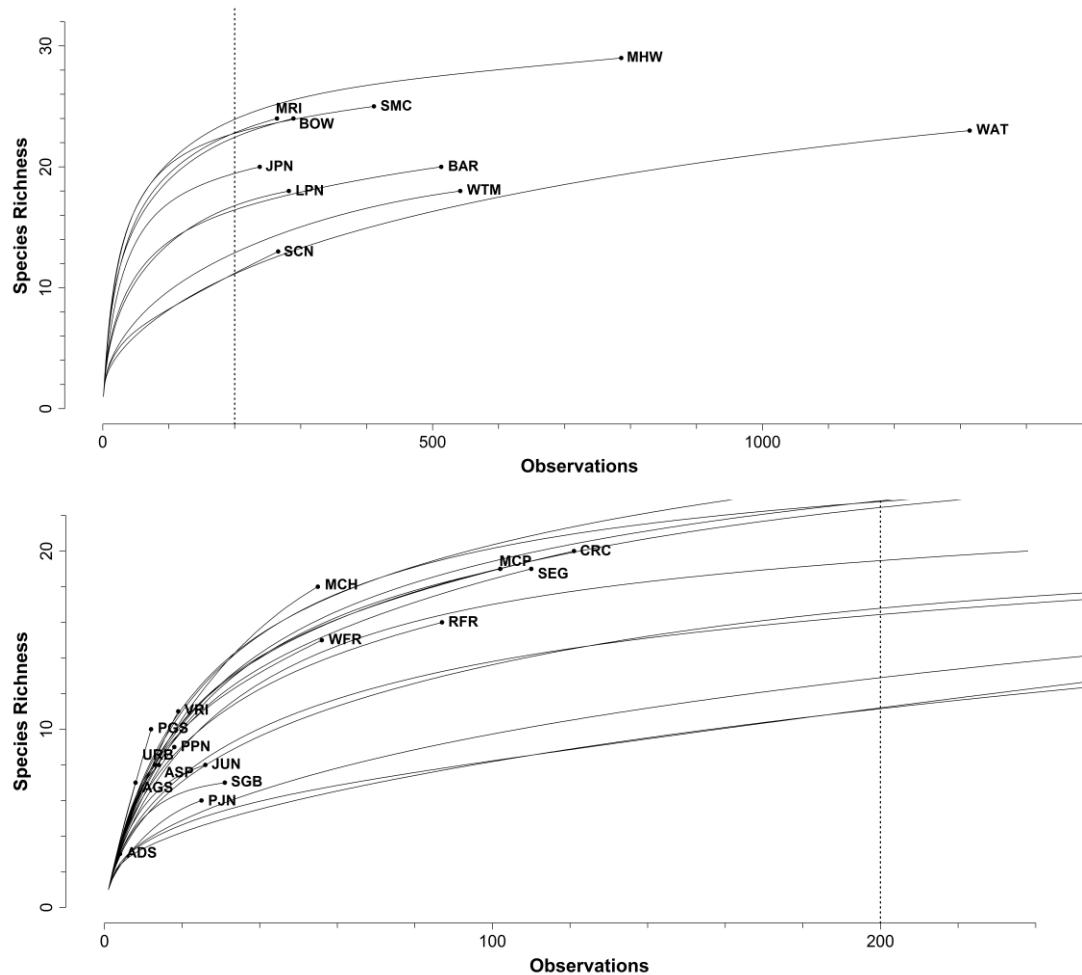
Expected species richness								
CWHR name	n = 100	n = 200	n = 400	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
Blue Oak Woodland	17.4	19.5	NA	20 (284)	20 (1.3)	20.4 (2.2)	2.57	0.904
Chamise - Redshank Chaparral	12.9	NA	NA	13 (112)	13 (NA)	13.3 (1.7)	2.33	0.885
Jeffrey Pine	14.5	15.0	NA	15 (231)	15 (NA)	15 (1.8)	2.13	0.801
Juniper	NA	NA	NA	5 (22)	5 (NA)	5 (0)	1.49	0.744
Lodgepole Pine	10.9	11.9	NA	12 (273)	12 (NA)	12 (1.7)	1.77	0.747
Mixed Chaparral	NA	NA	NA	5 (36)	5 (NA)	5 (1.1)	1.44	0.735
Montane Chaparral	NA	NA	NA	12 (93)	12 (NA)	12 (1)	2.14	0.829
Montane Hardwood	20.2	23.7	26.2	28 (785)	31 (NA)	29.2 (2.6)	2.78	0.918
Montane Riparian	16.1	17.0	NA	17 (254)	17 (NA)	17 (2.1)	2.46	0.889
Perennial Grass	NA	NA	NA	1 (3)	1 (NA)	1 (0)	0.00	0.000
Pinyon - Juniper	NA	NA	NA	2 (19)	2 (NA)	2 (0.7)	0.44	0.266
Ponderosa Pine	NA	NA	NA	1 (7)	1 (NA)	1 (0)	0.00	0.000
Red Fir	NA	NA	NA	9 (78)	9 (NA)	9 (1.2)	1.96	0.831
Subalpine Conifer	5.0	5.0	NA	5 (257)	5 (NA)	5 (0.9)	1.20	0.643
Giant Sequoia	12.0	NA	NA	12 (100)	13 (NA)	12.7 (1.4)	2.18	0.857
Sagebrush	NA	NA	NA	5 (28)	5 (NA)	5 (0.9)	1.45	0.727

Table S11 (continued). Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

CWHR name	Expected species richness			Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
	n = 100	n = 200	n = 400					
Sierra Mixed Conifer	18.9	20.3	21.0	21 (405)	21 (NA)	21.2 (2.2)	2.67	0.905
Urban	NA	NA	NA	0 (0)	0 (NA)	NA (NA)	0.00	1.000
Valley Foothill Riparian	NA	NA	NA	2 (8)	2 (NA)	3.1 (0.8)	0.38	0.219
Water	7.2	9.1	11.1	13 (1300)	13 (NA)	13.4 (1.8)	1.24	0.630
White Fir	NA	NA	NA	8 (48)	8 (NA)	8 (0)	2.01	0.859
Wet Meadow	7.4	8.4	9.0	9 (528)	9 (NA)	9 (1.5)	1.30	0.636
C. 95% rule								
Alpine Dwarf Shrub	NA	NA	NA	0 (0)	NA (NA)	NA (NA)	0.00	0.000
Annual Grass	NA	NA	NA	2 (2)	3 (NA)	NA (NA)	0.69	0.500
Aspen	NA	NA	NA	2 (3)	2 (1.3)	3 (0.9)	0.64	0.444
Barren	13.2	15.3	16.7	17 (510)	17 (0.7)	17.4 (2.1)	2.00	0.800
Blue Oak Woodland	17.3	19.9	NA	21 (282)	22.5 (7.2)	23 (2.4)	2.56	0.903
Chamise - Redshank Chaparral	14.7	NA	NA	15 (109)	16.5 (7.2)	16.9 (2)	2.35	0.882
Jeffrey Pine	14.8	15.9	NA	16 (214)	16 (1.3)	16.3 (1.8)	2.07	0.777
Juniper	NA	NA	NA	4 (18)	4 (0)	4 (0)	1.22	0.660
Lodgepole Pine	12.7	15.2	NA	16 (279)	16.3 (1.9)	16.9 (2)	1.87	0.758

Table S11 (continued). Rarefaction results of herpetofauna observations for Sequoia Kings Canyon National Parks by 500 m CWHR habitat category. The three rarefaction results refer to rarefaction estimates of species richness with (A) all observations; (B) species observations in elevation categories where there were three or fewer observations considered as stray observations and not included in the analysis unless the species had five or fewer total observations or no habitat received more than 3 observations; and (C) species observations in elevation categories where occurrence that fell in the bottom 5% of elevation category observations were eliminated as strays, unless no single elevation category garnered enough observations to be counted. Chao and ACE are two methods of calculating estimated species richness, and a standard error around that species richness.

Expected species richness								
CWHR name	n = 100	n = 200	n = 400	Species Observed (number of obs.)	Chao Projected species (s.e.)	ACE projected species (s.e.)	Shannon	Simpson*
Mixed Chaparral	NA	NA	NA	13 (43)	15 (3.7)	16.9 (2)	2.09	0.822
Montane Chaparral	NA	NA	NA	16 (90)	18 (5.3)	18.7 (1.7)	2.22	0.825
Montane Hardwood	20.2	23.7	26.2	28 (785)	31 (NA)	29.2 (2.6)	2.78	0.918
Montane Riparian	18.1	20.8	NA	21 (216)	21.8 (2.3)	23 (2.4)	2.53	0.887
Perennial Grass	NA	NA	NA	2 (2)	3 (NA)	NA (NA)	0.69	0.500
Pinyon - Juniper	NA	NA	NA	4 (22)	4 (1.3)	4.6 (1)	0.86	0.442
Ponderosa Pine	NA	NA	NA	4 (5)	5.5 (7.2)	10 (0.9)	1.33	0.720
Red Fir	NA	NA	NA	12 (76)	13 (3.4)	14.9 (1.9)	2.01	0.827
Subalpine Conifer	6.4	7.5	NA	8 (261)	8.5 (3.7)	11.8 (1.9)	1.28	0.653
Giant Sequoia	NA	NA	NA	15 (99)	17 (5.3)	18 (1.9)	2.25	0.858
Sagebrush	NA	NA	NA	3 (7)	3 (NA)	3.5 (0.8)	1.00	0.612
Sierra Mixed Conifer	18.2	20.2	NA	22 (390)	23.5 (7.2)	23.6 (2.4)	2.61	0.899
Urban	NA	NA	NA	4 (6)	4.3 (1.9)	6 (1.2)	1.33	0.722
Valley Foothill Riparian	NA	NA	NA	4 (4)	10 (NA)	NA (NA)	1.39	0.750
Water	7.8	10.4	13.4	18 (1309)	18.2 (1)	19.2 (2)	1.28	0.635
White Fir	NA	NA	NA	9 (42)	10 (NA)	9.9 (0.9)	2.01	0.851
Wet Meadow	9.2	11.8	14.4	15 (539)	15.5 (1.9)	1.41	0.650	



Figures S14. The rarefaction curves for the reptiles and amphibians species of SEKI NP, as calculated using 100 observations as a cutoff below which values for that habitat type were not considered statistically robust. The lower graph expands the left hand side of the upper graph to show curves for land cover types with small sample sizes.

Plants

The rarefaction tables showing the three ways of using the observation data to develop species richness and diversity measures are presented here, followed by the rarefaction curves developed only for method A, and used for all observations.

Table S12. This table shows plant diversity by elevation zone, with a minimum of 2000 observations per zone.

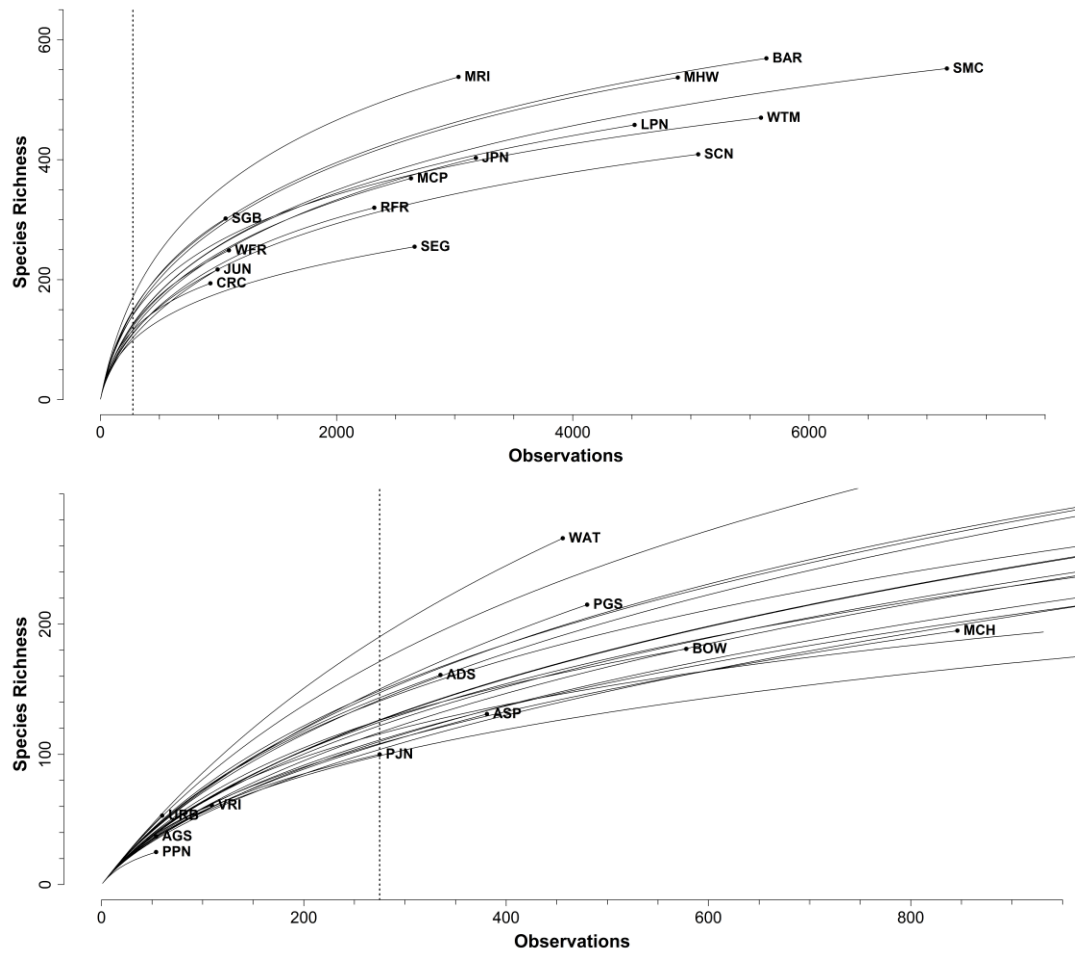
Elevation Range	Expected species richness				Total observed species	Total number of obs. (n)	projected total (chao1)	chao1 se	projected total (ACE)	ACE se	Shanno n	Simpson*	Inverse Simpson†
	n = 2000	n = 3500	n = 8000	n = 11000									
0-999	322.8	388.6	NA	NA	393	3631	514.0	29.9	514.3	11.4	5.11	0.989	94.3
1000-1499	376.3	462.4	NA	NA	469	3647	666.6	42.8	645.5	13.2	5.18	0.988	80.8
1500-1999	363.9	452.2	590.4	NA	598	8363	782.0	38.2	754.8	13.7	5.02	0.982	56.8
2000-2499	382.2	468.0	596.6	645.3	650	11352	781.5	28.7	776.5	13.9	5.20	0.986	69.2
2500-2999	404.5	482.9	590.7	629.5	647	12774	738.0	22.7	731.5	13.4	5.39	0.989	89.5
3000-3499	320.9	383.0	474.9	510.2	524	12429	661.0	35.7	618.4	12.4	5.13	0.988	85.5
>=3500	241.7	NA	NA	NA	258	2432	343.0	25.6	363.4	10.4	4.80	0.988	83.0

Table S13. Rarefaction table for species richness and diversity values for plant species by California Wildlife Habitat Relationship type in SEKI using an observation cutoff from 275 observations to 3000 observations.

CWHR name	n = 275	n = 500	n = 1000	n = 2000	n = 3000	Total observed species	Total of obs. (n)	projected total (chao1)	chao1 se	projected total (ACE)	ACE se	Shannon	Simpson*
Alpine Dwarf Shrub (ADS)	143.6	NA	NA	NA	NA	161	335	316.0	48.3	316.5	11.9	4.81	0.989
Annual Grass (AGS)	NA	NA	NA	NA	NA	37	54	77.6	27.2	86.2	4.3	3.48	0.964
Aspen (ASP)	107.8	NA	NA	NA	NA	131	381	307.6	65.6	280.3	9.7	4.23	0.971
Barren (BAR)	148.9	208.3	292.7	395.4	462.2	569	5639	719.7	31.2	726.1	13.6	5.43	0.993
Blue Oak Woodland (BOW)	126.2	169.8	NA	NA	NA	181	578	262.2	25.5	268.5	8.6	4.71	0.984
Chamise Chaparral (CRC)	115.7	152.4	NA	NA	NA	194	931	259.1	21.8	266.1	8.2	4.70	0.984
Jeffrey Pine (JPN)	116.9	167.1	241.7	333.2	393.9	403	3179	588.5	40.7	595.6	13.2	4.72	0.976
Juniper (JUN)	103.8	148.3	NA	NA	NA	217	992	425.4	58.0	455.8	14.5	4.36	0.971
Lodgepole Pine (LPN)	126.2	179.4	255.9	344.5	399.7	458	4523	628.7	38.9	598.0	12.3	4.90	0.976
Mixed Chaparral (MCH)	108.3	149.6	NA	NA	NA	195	846	316.4	35.5	350.5	11.4	4.54	0.981
Montane Chaparral (MCP)	122.1	171.9	244.4	331.3	NA	369	2630	533.5	38.1	532.6	12.2	4.88	0.984
Montane Hardwood (MHW)	141.8	201.7	287.9	390.8	456.6	537	4889	680.3	30.1	695.7	13.5	5.28	0.990
Montane Riparian (MRI)	171.4	246.3	349.5	466.0	536.2	538	3032	683.1	29.7	705.8	13.3	5.68	0.995
Perennial Grass (PGS)	150.2	NA	NA	NA	NA	215	480	410.0	49.1	498.6	16.1	4.92	0.988
Pinyon – Juniper(PJN)	100.0	NA	NA	NA	NA	100	275	153.7	22.4	153.7	6.4	4.12	0.970
Ponderosa Pine (PPN)	NA	NA	NA	NA	NA	25	54	40.6	16.4	43.4	4.3	2.97	0.933
Red Fir (RFR)	109.9	156.4	224.2	302.9	NA	320	2319	424.0	26.2	444.8	11.2	4.53	0.970
Subalpine Conifer (SCN)	111.1	154.7	217.7	293.6	342.9	409	5062	534.0	30.1	539.1	11.9	4.70	0.978
Giant Sequoia (SEG)	99.0	132.2	177.6	230.7	NA	255	2660	385.5	40.2	355.1	9.7	4.48	0.978
Sagebrush (SGB)	147.4	209.5	294.5	NA	NA	302	1060	429.0	30.4	457.2	12.4	5.15	0.990
Sierra Mixed Conifer (SMC)	126.6	179.8	256.6	349.5	410.8	552	7167	715.0	34.3	713.3	13.7	4.99	0.983
Urban (URB)	NA	NA	NA	NA	NA	53	60	182.4	73.5	227.1	2.6	3.93	0.979
Valley Foothill Riparian (VRI)	NA	NA	NA	NA	NA	61	109	96.1	17.7	99.5	5.1	3.95	0.977
Water(WAT)	190.4	NA	NA	NA	NA	266	456	504.7	52.8	513.1	12.3	5.40	0.994
White Fir (WFR)	124.8	173.4	240.1	NA	NA	249	1088	387.3	37.7	374.0	10.2	4.77	0.981
Wet Meadow (WTM)	141.0	193.4	263.6	341.9	390.6	470	5593	624.0	36.8	600.5	12.4	5.29	0.992

Table 14. The conditional Sorensen's index of dissimilarity of plant species by CWH type.

Code	ADS	AGS	ASP	BAR	BOW	CRC	JPN	JUN	LPN	MCH	MCP	MHW	MRI	PGS	PJN	PPN	RFR	SCN	SEG	SGB	SMC	URB	VRI	WAT	WFR
AGS	0.97																								
ASP	0.60	0.86																							
BAR	0.07	0.46	0.19																						
BOW	0.98	0.22	0.92	0.72																					
CRC	0.96	0.24	0.91	0.70	0.45																				
JPN	0.56	0.59	0.29	0.39	0.78	0.66																			
JUN	0.53	0.86	0.45	0.25	0.91	0.85	0.37																		
LPN	0.22	0.97	0.21	0.27	0.92	0.89	0.47	0.28																	
MCH	0.93	0.22	0.86	0.54	0.58	0.42	0.55	0.81	0.79																
MCP	0.52	0.30	0.25	0.31	0.71	0.64	0.38	0.37	0.46	0.44															
MHW	0.66	0.08	0.47	0.58	0.18	0.08	0.41	0.53	0.69	0.11	0.37														
MRI	0.21	0.41	0.14	0.35	0.65	0.60	0.42	0.31	0.29	0.53	0.34	0.58													
PGS	0.65	0.73	0.58	0.26	0.88	0.85	0.40	0.63	0.39	0.76	0.44	0.52	0.27												
PJN	0.69	0.62	0.74	0.30	0.79	0.65	0.39	0.53	0.61	0.51	0.32	0.22	0.40	0.68											
PPN	0.72	0.76	0.68	0.24	0.72	0.52	0.24	0.44	0.72	0.24	0.12	0.08	0.44	0.52	0.36										
RFR	0.39	0.92	0.29	0.23	0.93	0.86	0.42	0.41	0.23	0.78	0.41	0.56	0.26	0.41	0.68	0.60									
SCN	0.16	0.86	0.28	0.16	0.90	0.88	0.52	0.36	0.26	0.82	0.50	0.67	0.34	0.40	0.60	0.56	0.30								
SEG	0.83	0.49	0.56	0.43	0.85	0.75	0.35	0.68	0.54	0.59	0.38	0.38	0.40	0.55	0.65	0.28	0.51	0.61							
SGB	0.25	0.92	0.30	0.16	0.93	0.88	0.48	0.39	0.23	0.79	0.45	0.61	0.25	0.49	0.61	0.60	0.40	0.28	0.68						
SMC	0.53	0.24	0.24	0.47	0.58	0.43	0.25	0.36	0.50	0.33	0.22	0.39	0.44	0.30	0.29	0.12	0.32	0.51	0.15	0.44					
URB	0.87	0.95	0.79	0.42	0.87	0.94	0.43	0.72	0.36	0.91	0.45	0.57	0.23	0.68	0.92	0.96	0.57	0.53	0.53	0.58	0.28				
VRI	0.97	0.65	0.87	0.52	0.41	0.43	0.62	0.85	0.82	0.44	0.51	0.16	0.33	0.74	0.80	0.84	0.80	0.82	0.69	0.82	0.30	0.92			
WAT	0.45	0.62	0.57	0.24	0.77	0.79	0.64	0.63	0.38	0.80	0.60	0.61	0.31	0.60	0.68	0.56	0.53	0.34	0.77	0.52	0.54	0.79	0.72		
WFR	0.76	0.70	0.47	0.36	0.87	0.75	0.24	0.57	0.46	0.65	0.33	0.33	0.36	0.51	0.59	0.32	0.45	0.50	0.41	0.60	0.13	0.58	0.72	0.75	
WTM	0.20	0.92	0.26	0.30	0.92	0.89	0.51	0.37	0.29	0.82	0.50	0.73	0.29	0.39	0.70	0.60	0.31	0.34	0.53	0.28	0.54	0.41	0.85	0.33	0.49



Figures S15. The rarefaction curves for the plant species of SEKI, as calculated using 275 observations as a cutoff below which values for that habitat type were not considered statistically robust, and 2000 observations for elevation zone species richness. Upper graph shows entire range, lower graph focuses on low sample sizes, as depicted in the left portion of the upper graph.

Assessing the Elevation Distribution of Indicator Plant Species

The National Vegetation Classification System

(<http://biology.usgs.gov/npsveg/seki/metasekispatal.html>) provides a classification system that is mapped for the parks (Figure 7). Dominant and indicator species are characterized within the Parks by their elevation distribution.

Table S15 Dominant / Indicator species of the Sequoia Kings Canyon vegetation map and the distribution attributes of the polygons in which they dominate. Data are depicted in the main body of the text in Figure 22.

Species	Minimum Elevation (m)	Maximum Elevation (m)	Mean Elevation	StdDev	Sample Size
<i>Platanus racemosa</i>	394	1314	685	164.5	73
<i>Bromus spp.</i>	420	1322	707	180.2	157
<i>Daucus pusillus</i>	420	1322	707	180.2	157
<i>Salix laevigata</i>	577	1011	748	159.1	13
<i>Quercus douglasii</i>	420	1322	750	200	261
<i>Quercus wislizeni</i> var. <i>wislizeni</i>	420	1874	850	223.1	926
<i>Vitis californica</i>	511	1076	860	232.2	9
<i>Cercis canadensis</i> var. <i>texensis</i>	423	1696	897	224.1	443
<i>Aesculus californica</i>	423	1629	948	257.7	640
<i>Fremontodendron californicum</i> ssp. <i>californicum</i>	550	1696	1000	233.5	96
<i>Eriodictyon californicum</i>	561	1568	1024	220.3	119
<i>Adenostoma fasciculatum</i>	510	1671	1025	218.3	919
<i>Yucca whipplei</i>	447	2040	1110	318.3	196
<i>Ceanothus leucodermis</i>	856	1623	1145	168.4	51
<i>Ceanothus cuneatus</i>	490	1619	1173	268.7	44
<i>Cercocarpus montanus</i> var. <i>glaber</i>	423	2025	1200	309.8	1400
<i>Quercus garryana</i> var. <i>breweri</i>	895	1712	1340	168.1	345
<i>Umbellularia californica</i>	651	2027	1364	270.3	410
<i>Alnus rhombifolia</i>	577	1971	1379	370.8	102
<i>Pteridium aquilinum</i>	1119	2063	1547	236.4	23
<i>Arctostaphylos mewukka</i>	1246	1944	1578	147.3	119
<i>Arctostaphylos viscida</i>	636	2545	1595	417.1	1162
<i>Pinus ponderosa</i>	817	2237	1610	222.6	723
<i>Quercus chrysolepis</i>	438	2597	1624	426.3	2952
<i>Acer macrophyllum</i>	1262	2130	1662	221.7	56
<i>Calocedrus decurrens</i>	817	2421	1686	249.8	1048
<i>Quercus kelloggii</i>	892	2596	1737	290.9	1577
<i>Chamaebatia foliolosa</i>	1264	2349	1747	206	338
<i>Ceanothus integerrimus</i>	1369	2377	1773	209.4	192

Table S15 (continued) Dominant / Indicator species of the Sequoia Kings Canyon vegetation map and the distribution attributes of the polygons in which they dominate. Data are depicted in the main body of the text in Figure 22.

Species	Minimum Elevation (m)	Maximum Elevation (m)	Mean Elevation	StdDev	Sample Size
<i>Cornus nuttallii</i>	1442	2168	1864	156.8	99
<i>Sequoiadendron giganteum</i>	1442	2302	1899	170.7	126
<i>Populus balsamifera ssp. trichocarpa</i>	1211	2683	1965	290	182
<i>Pinus lambertiana</i>	1321	2661	1966	245	803
<i>Pinus monophylla</i>	1385	2545	1989	240.7	374
<i>Abies concolor</i>	1201	2877	2237	268.9	2555
<i>Symphoricarpos rotundifolius</i>	1792	2796	2314	188.2	358
<i>Elymus elymoides</i>	1792	2796	2314	188.2	358
<i>Pinus jeffreyi</i>	1670	3032	2328	236.5	2315
<i>Betula occidentalis</i>	2111	2926	2478	207	34
<i>Arctostaphylos patula</i>	1114	3524	2511	352.8	5967
<i>Prunus emarginata</i>	1522	3271	2558	300.5	807
<i>Acer glabrum</i>	1645	3271	2570	283.7	603
<i>Ribes spp.</i>	1645	3271	2570	283.7	603
<i>Ceanothus cordulatus</i>	1114	3524	2583	335.7	3911
<i>Hieracium albiflorum</i>	2037	3040	2655	204.3	415
<i>Abies magnifica</i>	1670	3212	2675	236.9	4056
<i>Poa pratensis</i>	2333	2985	2679	137	28
<i>Chrysolepis sempervirens</i>	1114	3524	2695	309.9	4882
<i>Juniperus occidentalis var. australis</i>	2095	3202	2719	196.9	1342
<i>Cercocarpus ledifolius</i>	2251	3301	2737	232.1	202
<i>Populus tremuloides</i>	1819	3354	2765	222.1	1057
<i>Arctostaphylos nevadensis</i>	2250	3257	2771	155.1	829
<i>Artemisia tridentata</i>	1632	3435	2778	247.3	1626
<i>Pinus flexilis</i>	2456	3529	2809	186.3	67
<i>Salix spp.</i>	491	3517	2819	381.6	2927
<i>Pinus monticola</i>	1795	3273	2850	156.5	3193
<i>Vaccinium uliginosum</i>	2030	3373	2883	258.6	426
<i>Tsuga mertensiana</i>	2728	3254	3000	121.5	165
<i>Pinus contorta var. murrayana</i>	2030	3601	3018	244.9	7672
<i>Holodiscus discolor</i>	2040	3743	3111	282.3	2717
<i>Carex rossii</i>	2500	3459	3148	141.7	1438
<i>Artemisia tridentata var. vaseyana</i>	2040	3743	3188	257.6	2075
<i>Pinus balfouriana ssp. austrina</i>	2635	3782	3192	161.9	3741
<i>Artemisia rothrockii</i>	2040	3743	3192	254.7	2155
<i>Phyllodoce breweri</i>	2040	3863	3209	253.6	2353

Table S15 (continued) Dominant / Indicator species of the Sequoia Kings Canyon vegetation map and the distribution attributes of the polygons in which they dominate. Data are depicted in the main body of the text in Figure 22.

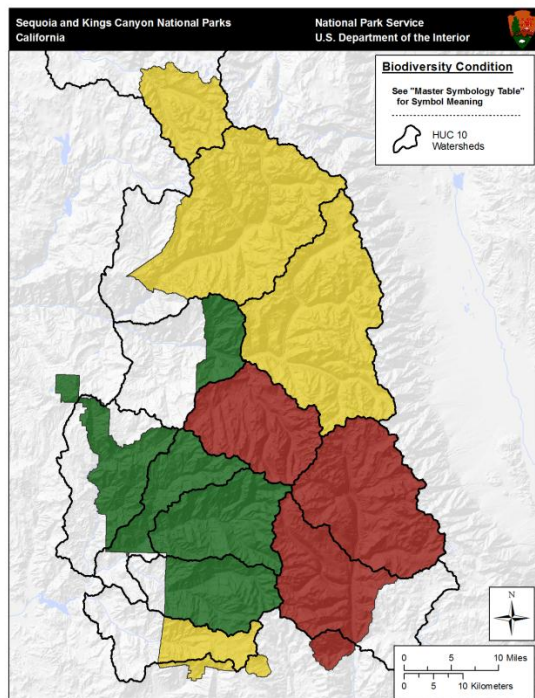
Species	Minimum Elevation (m)	Maximum Elevation (m)	Mean Elevation	StdDev	Sample Size
<i>Carex exserta</i>	2500	3794	3265	164.8	3746
<i>Allium validum</i>	2788	3754	3283	139	1954
<i>Salix orestera</i>	2788	3754	3283	139	1954
<i>Pinus albicaulis</i>	2500	3786	3288	170.1	5897
<i>Penstemon davidsonii</i>	2844	3786	3393	152.4	1810

Assessment

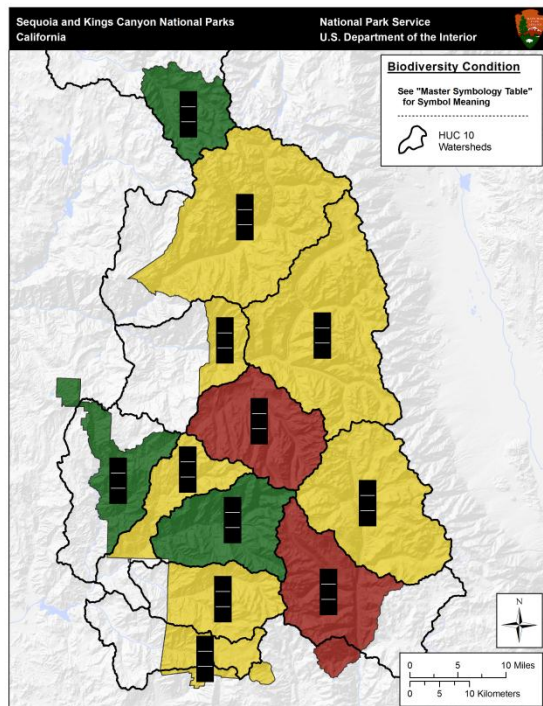
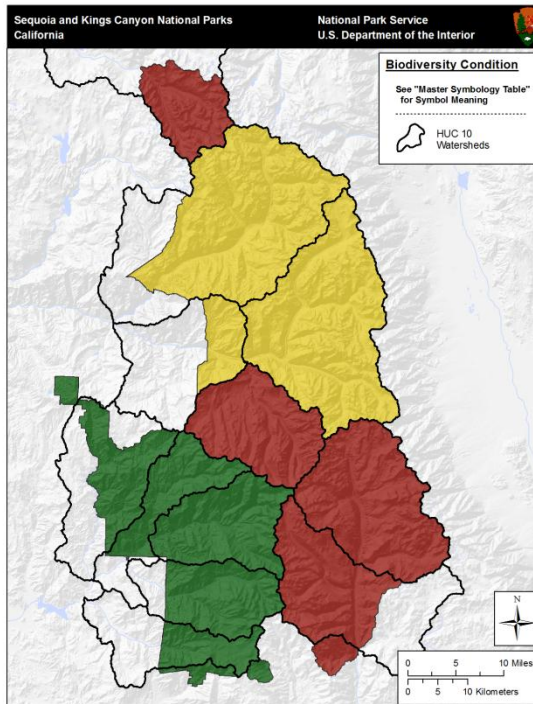
The assessment includes a roll-up of biodiversity state assessments by large watershed units (HUC-10).

We then did a roll-up of biodiversity status by taxonomic group. To do this, we used four measures. These were: (a) the inverse Simpson's Diversity index of observations within a watershed unit; (b) the estimated species richness of observations within a watershed unit; (c) the inverse Simpson's diversity index estimated by a weighted average of cover types and the estimated diversity of each cover type; and (d) the estimated species richness as a weighted average of cover types within a watershed unit and the estimated species richness of that land cover type. These four measures were then converted to a standard score $((\text{observation} - \text{mean}) / \text{standard deviation})$ and summed so that each weighed equally in the total. These summed weighted standard scores were then color coded (green = high, Yellow = intermediate; red = low) based on the sum of standard scores. Strongly positive net scores were scored green; strongly negative numbers represent indices that are consistently below the average and these were scored red; others were mixed or consistently near the mean and these were scored yellow. Table S14 summarizes all of the input data for these maps. Table S15 and Figure S17 identify these watersheds by name and HUC10 designation.

A. Rolled up Biodiversity



B. Simpson's Index



C. Species Richness Estimate

Figure S16. Three attempts to roll up biodiversity that were amalgamated into the final roll-up (Figure 27). A) the value of rolled up biodiversity from Figure 38 was weighted by habitat area for each Huc10, then standardized [(Observed – Average) / Average]. B. The same as in A, except using the wildlife observations from within each Huc10 to calculate Simpson's Index of diversity by taxonomic group. Group scores were then standardized and summed. Strongly positive scores were weighted green, strongly negative scores were weighted yellow. C. Species richness estimated based on habitats and the rarefaction estimate of species richness; standardized as in B.

Table S16. Output statistics for assessing biodiversity condition by watershed. Number of observations, number of species and a Simpsons diversity index for each taxa (birds, mammals, herpetofauna and plants) for each HIC10 watershed. These data are paired with estimates of species richness and Simpsons diversity index calculated by using estimates of these values by land cover, and calculating a watershed value as a weighted average based on the amount of land cover in each type in each watershed. These data were used to roll-up watershed condition based on values that were far above, near, or far below average for each watershed.

	Middle Fork Kings River	Upper South Fork San Joaquin River	East Fork Kaweah River	North Fork Kaweah River	Marble Fork Kaweah River- Kaweah River	Lower South Fork Kings River	South Fork Kaweah River	Golden Trout Creek- Kern River	Upper South Fork Kings River	Rock Creek- Kern River	Middle Fork Kaweah River	Roaring River
A. Birds												
Number of Observations	4238	2995	5545	4878	11996	13047	2302	2235	4992	3384	1426	1203
Number of Species Observed	128	128	158	149	155	178	131	106	146	127	116	89
Estimated Species Richness (n = 1000)	92.5 (3.6)	102.8 (3.4)	126.8 (3.4)	109.4 (3.7)	108.4 (3.5)	132.4 (3.6)	108.6 (3.4)	92.0 (2.8)	105.6 (3.7)	105.3 (3.2)	108.4 (2.4)	85.2 (1.8)
Simpson's Index	30.43	36.15	70.15	56.72	50.33	74.3	43.98	33.72	42.45	46.98	41.71	25.29
Land Cover, Species Richness Estimate	79.91	78.28	87.63	85.24	89.91	85.62	83.06	78.93	79.06	79.78	80.69	80.71
Land Cover, Simpson's index	34.86	35.17	47.09	44.18	52.53	45.99	42.87	37.07	36.38	37.88	43.67	36.24
B. Mammals												
Number of Observations	1161	838	2127	1240	1316	3581	729	465	1460	577	302	431
Number of Species Observed	41	38	57	48	54	67	42	30	47	36	38	30
Estimated Species Richness (n=300))	27.0 (2.1)	29.0 (2.0)	32.5 (2.7)	33.2 (2.4)	34.1 (2.5)	34.8 (2.7)	31.9 (2.2)	26.3 (1.6)	28.2 (2.4)	30.3 (1.9)	37.9 (0.2)	27.4 (1.4)
Simpson's Index	9.78	6.92	7.9	9.42	12.8	11.02	6.6	7.66	10.07	10.73	12.37	11.56
Land Cover, Species Richness Estimate	25.82	25.21	27.34	27.73	28.77	27.67	28.93	26.29	25.35	25.55	27.65	26.21
Land Cover, Simpson's index	9.98	9.89	9.05	9.16	8.92	8.99	9.22	9.66	9.7	9.49	9.05	9.97
C. Herpetofauna												
Number of Observations	396	308	371	224	273	831	379	157	926	970	115	124
Number of Species Observed	11	20	25	20	26	32	21	13	19	17	14	10
Estimated species richness (n = 124)	8.6 (1.2)	15.7 (1.5)	21.2 (1.3)	17.9 (1.2)	21.9 (1.4)	24.3 (1.8)	18.7 (1.1)	12.5 (0.6)	12.4 (1.5)	9.6 (1.4)	14.0 (0.0)	8.8 (0.9)
Simpson's Index	2.53	3.79	11.94	8.24	12.51	11.62	11.83	3.6	3.99	3	6.41	3.73

Table S16 (continued). Output statistics for assessing biodiversity condition by watershed. Number of observations, number of species and a Simpsons diversity index for each taxa (birds, mammals, herpetofauna and plants) for each HIC10 watershed. These data are paired with estimates of species richness and Simpsons diversity index calculated by using estimates of these values by land cover, and calculating a watershed value as a weighted average based on the amount of land cover in each type in each watershed. These data were used to roll-up watershed condition based on values that were far above, near, or far below average for each watershed

	Middle Fork Kings River	Upper South Fork San Joaquin River	East Fork Kaweah River	North Fork Kaweah River	Marble Fork Kaweah River- Kaweah River	Lower South Fork Kings River	South Fork Kaweah River	Golden Trout Creek- Kern River	Upper South Fork Kings River	Rock Creek- Kern River	Middle Fork Kaweah River	Roaring River
Land Cover, Species Richness Estimate	13.65	12.94	13.42	12.52	16.37	13.18	12.28	12.86	13.34	13.23	13.87	14.36
Land Cover, Simpson's index	4.44	4.73	8.15	7.72	10.07	8.31	7.44	5.51	5	5.46	7.69	4.63
D. Plants												
Number of Observations	4183	3432	3840	6306	4285	7585	1369	2987	5564	5364	1138	1786
Number of Species Observed	384	451	612	629	553	783	396	431	623	581	244	275
Estimated species richness (n = 1184)	248 (6.8)	303.3 (7.6)	369.4 (9.0)	338.5 (9.0)	343.1 (8.3)	423.4 (9.7)	362.3 (4.9)	287.5 (7.7)	337.1 (9.0)	340.1 (8.6)	244.0 (0.0)	234.9 (4.9)
Simpson's Index	102.09	76.32	142.64	108.18	114.97	207.33	154.88	43.72	105.8	129.09	45.1	66.84
Land Cover, Species Richness Estimate	135.49	127.43	131.82	126.17	125.98	125.97	122.53	129.37	134.65	134.3	123.69	140.37
Land Cover, Simpson's index	105.09	80.35	87.64	74.65	69.13	74.55	63.72	84.01	101.23	99.06	64.42	113.39

Table S17. Watershed Identification lookup table. Watershed numbers correspond to watersheds in Figure S17 and are linked to rarefaction graphs for each taxa for each watershed (Figure S18).

Number	HUC_10	HU_10_Name
1	1803001003	Middle Fork Kings River
2	1804000602	Upper South Fork San Joaquin River
3	1803000702	East Fork Kaweah River
4	1803000703	North Fork Kaweah River
5	1803000704	Marble Fork Kaweah River-Kaweah River
6	1803001004	Lower South Fork Kings River
7	1803000705	South Fork Kaweah River
8	1803000102	Golden Trout Creek-Kern River
9	1803001002	Upper South Fork Kings River
10	1803000101	Rock Creek-Kern River
11	1803000701	Middle Fork Kaweah River
12	1803001001	Roaring River

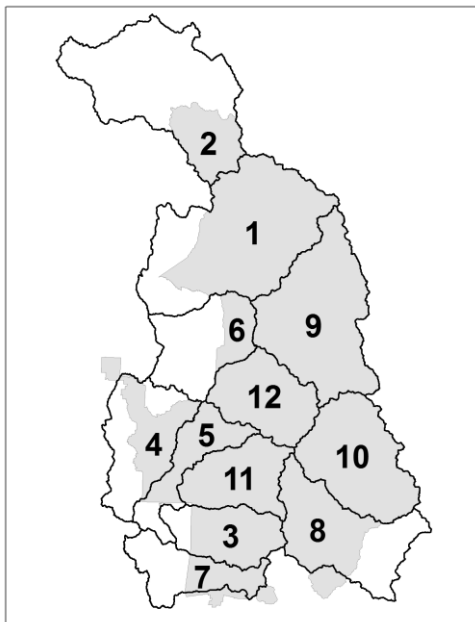


Figure S17. A map of SEKI identifying the 12 major watersheds named and number in Table S15.

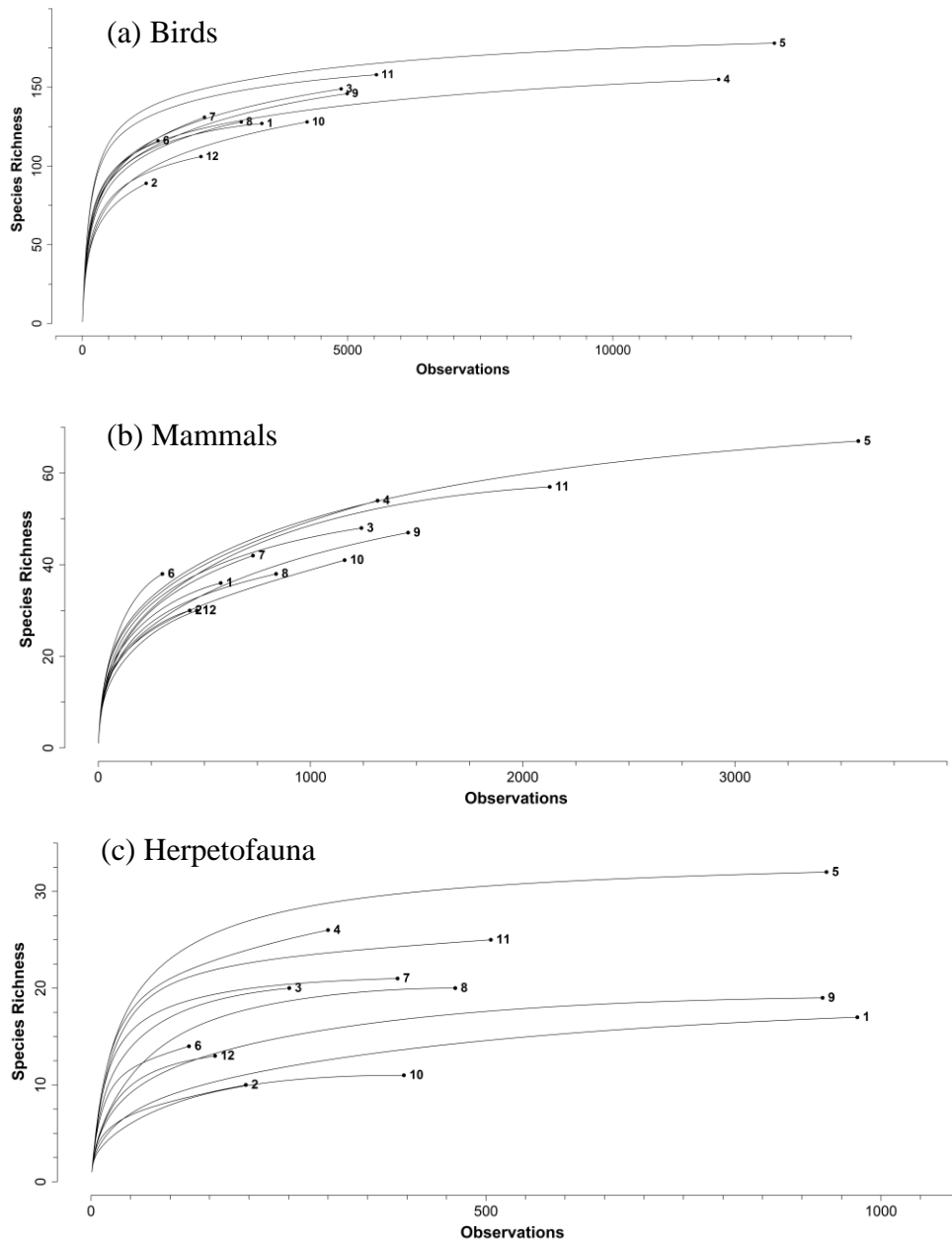


Figure S18. Rarefaction graphs for estimating species richness for (a) birds, (b) mammals; and (c) herpetofauna; and (d) plants. Cutoffs for data presentation are $n = 1000$, $n = 300$, and, $n = 124$, respectively.

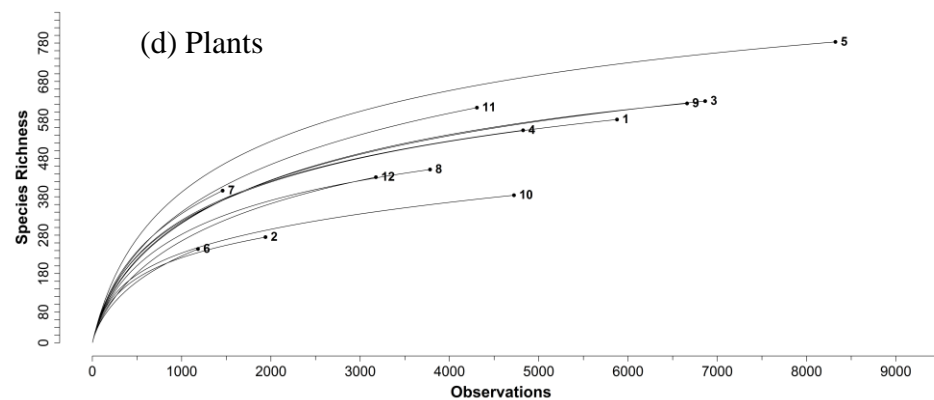


Figure S18 (continued). Rarefaction graphs for estimating species richness for (d) plants. $n = 1184$.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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